THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, MAY, 1888.

THE June number of the RAILROAD AND ENGINEERING JOURNAL will contain the first part of a Study on Steam Hammers, by M. Chomienne, the distinguished French engineer, who has had many years' experience in forge management and construction. This paper will be published by special arrangement with the Author, and is translated from his manuscript for the JOURNAL.

The publication will extend over several months, and the articles will be very fully illustrated, the engravings being prepared from drawings made under M. Chomienne's direction.

WE give this month illustrations and descriptions of two systems of naval coast defense, which are just now attracting much attention here and abroad. The Nordenfelt submarine torpedo boat, of which we have heretofore spoken, has been adopted by several European Governments, and is certainly very formidable within its limited range of action. The Zalinski dynamite gun and cruiser have a much wider range of action and seem to us to be more dangerous weapons, both in attack and defense, than any yet invented. Certainly the dynamite gun has many advantages over any form of submarine torpedo, whether operated from shore or from a boat, and there is little doubt that this will be completely shown by practical tests, whenever they can be made.

THE project for bridging the Hudson River at New York City has so far assumed form that a bill authorizing the building of such a bridge has been introduced in the New York Legislature. A somewhat wide range is given in the matter of location, for the provisions of the bill are that it shall cross the river at some point between 10th and 181st streets, the exact place to be decided on by a commission. It provides for spans not less than 1,300 ft. each, with one pier in the river and a clear height of 130 ft. above high water. The bill does not provide directly for the incorporation of a company, leaving that to the commission which is to be appointed by the Governor.

In the present condition of legislative business at Albany it is doubtful whether such a bill can pass this session. In any event, should a company be organized under its provisions a charter from the State of New Jersey as well as in New York will be required, and also some legislation from Congress.

THE death of General Q. A. Gillmore last month removed from the Army an officer whose services in the field earned him a reputation as a military engineer of the first rank. During the war he was the first officer who realized the capacity and range of rifled cannon, and made use of them in such a way as to secure the full results attainable from what were then the best guns; and in the operations around Charleston and against Fort Pulaski he accomplished several things which had generally been considered impossible up to that time. In a military government he would have attained high rank; in our own he was employed after the war in doing his full share of the varied work which falls upon the Engineer Corps. He could probably have earned wealth and a high position as a civil engineer had he left the Army; but his life had been spent in it, and he preferred to remain there. His ability was generally recognized, however, and few men in the service had a greater reputation outside. Notwithstanding a very busy life, he found time to put many of his experiences on record, and to publish them, and so earned the gratitude of the profession.

DURING the past month there have been an unusual number of deaths of prominent engineers and railroad men, as our obituary column will show. Some of these men belonged mainly to the past, like President Hinckley and Squire Whipple, whose active life was over; others, like Charles Latimer and General Gillmore, were still strong men, and in the ordinary course of events might have looked forward to many years of usefulness. General Gillmore has fortunately left behind him, in his published works, a record of many of his experiences for the instruction of those engineers who may come after him; but Mr. Latimer, than whom few men were more capable of giving practical and thorough instruction in his branch of the profession, has left few records of his experience.

THE new system of payment of car mileage by a mixed mileage and per-diem rate, which has been adopted by several leading roads, has been reviewed and endorsed by a committee of the General Time Convention. This committee reports that the new system has been in operation on 34 lines, including over 23,000 miles of railroad, and that the results so far have been most excellent. The Convention took no action on the report; it was laid over until the next meeting, but there seems to be little doubt that the mixed system will be approved and recommended for general adoption.

OUR Canadian brethren are just at present wrestling with the question of Government regulation of railroads. A Commission was appointed last year to take testimony of this subject and to report to Parliament; this report has just been presented, and is a long and elaborate document.

To speak briefly, the Commission recommends the appointment for the Dominion of Canada of a railroad commission, with certain powers of control and regulation. The bill which has been prepared follows nearly the general outline of our own Interstate Commerce Law. The report is not final and is subject to revision by the Government, which may adopt the proposed bill complete or take up only a part of it.

One important point of difference between the Canadian railroads and our own is that the Government of Canada owns and operates directly the Intercolonial and two or three other lines of considerable importance, and that a large number of the roads have been built by the aid of subsidies by the Government; a condition of things which does not exist on this side of the line.

THE *Railway Age* publishes statistics collected by it in relation to track laying during the current year. From its figures it appears that from January 1 to March 31 there were laid in the United States 1,096 miles of track, a few miles more than during the corresponding time last year. As might be expected, the larger part of this work was in the Southern States, the weather in the North and Northwest generally preventing new track work during the winter months. The conclusion drawn by the *Age* is that the mileage of new railroads to be built this year will be probably much larger than has generally been expected, and that it may possibly almost reach last year's figures.

This conclusion does not seem to be altogether warranted by the facts. After a year of extensive construction such as 1887 was, there are always a great many lines left in an unfinished condition, and the track on these is very apt to be laid as early as possible in the following year. Much of this work has already been done, and, with the exception of two or three in the Southwest, there are now no long lines in progress upon which much work is likely to be done this season.

As we have already said, it is true that there are an enormous number of new projects, and that many new companies have been and are continually being organized. This amounts to very little, however, and the greater part of these companies are simply the after-crop of a period of extravagant construction, the prospects being that very few of them will ever build railroads anywhere except on paper.

It is also an incentive to construction that rails and other material are much cheaper than they have been for some time past. It does not follow, however, that new construction will be stimulated thereby, the fact being that while material is cheaper, it is not now an easy matter to get money for new projects.

We do not mean to say that there will not be a good many miles of railroad built this year, but the present prospect is that there will not be nearly as many as last year; probably less than the 8,000 miles which the *Age* gives as the minimum estimate. New companies, as we have said, find it very difficult to get money, and some of the old companies are reaching a point where their credit will not stand further loans at moderate interest. The fact is, as every one who has studied the matter knows, that the building of competing lines in new territory was entirely overdone last year. While many branch lines were constructed which are sure in course of time to build up a prosperous country and to make themselves well-paying feeders, could they have the field to themselves, there has been too much work done in building two or three roads in districts which are not and will not be able to properly support one road for the next five or ten years to come.

These lines must be operated, and they must cost something to work. The expense of working them has already been seriously felt by several of the companies which have been the greatest sinners in this direction, as their reports begin to show. The indications are that this kind of work will be more limited in amount this year than last, and this will not be altogether a misfortune.

IN Austria-Hungary, as in the United States, railroad building was active last year. There were added to the railroad lines of that country during the year 1,281 kilometers (796 miles) of new road, being an increase of about 5½ per cent. This is the largest addition made since 1873, when 1,703 kilometers were built, though 1884 came very near it, with 1,250 kilometers. The greatest mileage ever built in one year was 2,129 kilometers, in 1872. After 1873 the new construction fell off sharply to 504 kilometers in 1874, and then gradually declined to 61 in 1880. In the next year building was resumed and increased rapidly until 1884, but there was a great falling off in the two succeeding years, 1885 showing only 495 and 1886 only 672 kilometers. The fluctuations of new railroad building have thus followed pretty closely those of our own country.

Of the new line built last year just half—640 kilometers—were local and branch roads (vicinalbahnen), belonging to the Imperial State railroad system. About 30 per cent. of the total belonged to the State lines also, only 258 kilometers, or 20 per cent., having been built by the private railroad companies.

Hungary had the greater share of the new lines, 750 kilometers, against 531 in Austria. This has been the case for several years past. Austrian writers call this the era of local development in the railroad system, and note that the State system is increasing much faster than the private lines.

At the close of 1887 there were in the Empire 23,926 kilometers (14,868 miles) of railroad, of which 14,187 kilometers were in Austria and 9,739 in Hungary. There is evidently more room for development in the latter country, which has a greater area, but a less dense population, than the former.

PROBABLY there is no country in the world in which the question of irrigation has been more carefully studied than in India, and there is none in which it has been carried out on a more extensive scale. An instance of what has been done in this direction is found in a recent official report on the system of irrigation canals in the Punjab. At the close of 1887 there were in that province a total length of 3,770 miles of main canal and 5,675 miles of auxiliary distributing channels, which served to irrigate a total of 1,950,640 acres of land. The crops taken from this area were last year very nearly equal in value to the entire cost of the system. Some of the main canals are of great length, the Muzuffargarrh Canal having 693 miles of water-way, the Lower Sutlej 674, the Indus Canal 651, and the Sirhind Canal 536 miles, while there are three others over 200 miles in length. The system has been so successful that it is to be considerably extended; 106 miles of main canal and about 1,000 miles of distributing channels are now under construction, while surveys have been made for other lines.

As an investment these canals have been satisfactory to the Government as well as to the landowners. The net return to the Government last year was equal to 3½ per cent. on their cost, and more is expected when the system is fully completed. The increase in production is not stated, but it has been very large.

The Punjab, it is stated, presents an admirable field for irrigation. The land is of good quality, but production has been limited by a scanty and uncertain rainfall. The supply of water, however, is abundant, as the country is intersected by numerous rivers, which are fed by the mountain streams and snows of the Himalayas. There is also a population large enough to cultivate all the land, when there is a certainty of water-supply and consequent good crops.

Indirectly the extension of these works is of interest to American producers, as nearly half the irrigated area was last year planted in wheat; and Indian wheat is fast becoming a formidable competitor of American grain in the English market.

EVER since the English conquered and annexed Burmah, they have been trying to open a railroad route from the upper part of that country into India. The object is not only to strengthen their military position, but also, by an extension of the line eastward, to secure the trade with China, which is now carried on by caravan, and which is already considerable, but which could be largely increased by a railroad. Recent explorations have shown the existence of several low passes in the Patkoï Mountains —heretofore considered impassable—and the road will probably be built.

THE Russian engineers on the new line in Central Asia have been much troubled with sand-drifts blocking the line. From Merv to the crossing of the Amu-Daria the line runs across a plateau, which is peculiarly exposed to high winds, and where the soil is light and sandy, with very little vegetation. After many experiments they have settled on the use of a native bush called *saksaoul*, which grows rapidly, sometimes to a height of 15 or 20 ft., and sends its roots down very deep into the sand. A plantation of this bush along the line not only covers and consolidates the soil on which it grows, but also interposes an effectual barrier to the drifting of sand from the bare plains beyond. The *saksaoul* bushes are being planted all along the line, and strict orders have been issued against cutting them down either in the new plantations or in those already existing. Other methods have been tried, but this seems the most promising.

Much trouble from the same cause was experienced on the Southern Pacific line across the Yuma Desert in Southern California. The sand-drifts were much worse to handle than snow-drifts, for the reason that sand packs down hard where it drifts and cannot be handled by a snow-plow, the shovel being the only resort. On the Southern Pacific the only effectual preventive has been to encourage the growth of vegetation wherever possible, and the Russians seem to have reached the same conclusion.

A NEW one-rail railroad has recently been completed between Listowell and Ballybunion in Ireland. It is 10 miles long and is on the Lartigue system, consisting of a line carried on posts and having a cross section like a letter A. The weight is carried on the top rail, the cars, which are shaped like a saddle, fitting over the top of the A, having wheels or rollers below merely to steady them and keep them in place. The new line is intended to serve a light local traffic, and carries both passengers and freight. It follows closely the line of a highway road, and its cost was quite small. It is reported to be working very successfully thus far.

AUTOMATIC CAR COUPLERS.

THE announcement and an engraving of the long-expected "contour lines" for the Master Car-Builders' standard type of automatic coupler will be found on another page. As this is the consummation of lengthy investigations and somewhat warmly contested disputes over an important question, a statement of what has been done will probably interest many of our readers. The subject of car couplers has always attracted a good deal of attention in the Master Car-Builders' Association, and has been up for discussion annually for so long that the "memory of man runneth not to the contrary."

At the convention held in Saratoga in 1884 a resolution was adopted to the effect that it was "the sense of the convention that the best coupler mechanically is one which performs the coupling along a vertical plane." This resolution was unanimously adopted, although it was doubtful whether, at the time, most of the members who voted for it understood its significance. The description of the class of couplers referred to as those "which perform the coupling along vertical planes," was not very correct nor accurately descriptive, as it would be hard to designate a plane, either actual or imaginary, along which the coupling is performed. If the class of couplers referred to had been described as those which perform the coupling along vertical *surfaces*, it would have been more correct, although that would still have been a little vague. The class of couplers referred to couple by means of hooks which engage with each other and whose surfaces of contact are vertical. The most notable of these couplers are the Miller and Janney, both used extensively on passenger cars, and the Janney to a considerable extent on freight cars.

Owing to the fact that the resolution adopted at Saratoga was not understood at the time of its adoption by more than a very few of those who voted for it, it had a very slight influence on the action of the members of the Master Car-Builders' Association or the railroad companies of the country. At the meeting held the next year at Old Point Comfort a motion was adopted "to refer to the Executive Committee the subject of automatic freight-car couplers, with the power to arrange for and conduct a public trial at some central point, to employ one or more experts, and to solicit the co-operation of the railroad companies in making trials and in furnishing the funds for conducting the same."

In accordance with this resolution, a public trial of couplers was made at Buffalo, N. Y., in September, 1885, and twelve different kinds of couplers were recommended "for further trial in actual service."

Most of those recommended were put into actual service during the following year, and much valuable experience was gained from their use.

Last year, at the convention held in Minneapolis, the Executive Committee made a lengthy and final report on automatic couplers, and concluded with the recommendation:

"That this Association recommend as a standard form of coupling the Janney type of coupler; that the Association procure one of the present make of Janney couplers, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will automatically couple to and with this coupler under all conditions of service are to be considered as within the Janney type, and conforming to the standard of this Association."

This recommendation was submitted to letter-ballot, and was approved by a vote of more than two-thirds of the ballots cast. A sub-committee was then appointed to "procure one of the present make of Janney couplers." The committee, after careful investigation, recommended the form of contour lines of the Janney coupler, represented by the engraving on another page, as the standard of the Association.

During the investigations of the sub-committee it was found that these contour lines were the subject of a patent granted to Mr. Janney in 1879. With very great liberality the company which controls this patent agreed to waive their rights to the contour lines as described in the patent referred to—as is detailed in a circular issued by order of the Executive Committee of the Master Car-Builders' Association, and which is also published on another page.

It will be seen that this action of the Association—which is the culmination of the investigations carried on for a number of years past—is very important. It establishes a distinct class of couplers as a standard, and it designates the form of the coupling faces so as to insure interchangeability, or, rather, intercoupleability—to coin a word—of different kinds of couplers of the vertical surface type. The field is left open for inventors to improve this type of couplers, but confines their improvements to forms which will couple with each other. It will also be an immense relief to railroad managers, car-builders, and editors of technical papers to have an extinguisher for the great army of cranks who have been devoting their time and ingenuity to the invention of couplers of all degrees of impracticability. To these and to all other inventors it may now be said that the action of the Master Car-Builders' Association, so far as it has any influence, excludes all couplers which do not "perform the coupling along vertical surfaces" whose contour lines are of the form prescribed by the Association.

Doubtless there is still room for improvement of this type of coupler, and inventors now have the advantage that the direction in which they must work is indicated to them, and also that if they can make any real improvement in this class of couplers they may be quite sure that their inventions will receive consideration. Couplers of the Janney, or, as it has been rechristened, the M.C.B. type, are sure to be put into service in large numbers. Naturally railroad companies will want to get the best form of that type. By the action of the Master Car-Builders' Association car couplers, instead of being one of the most hopeless subjects on which invention can be exercised to advantage to the inventor, now promise a rich reward to whoever can make a real improvement in the construction of the type which has been adopted.

NEW PUBLICATIONS.

MECHANICAL DRAWING: BY LINUS FAUNCE. Boston; W. J. Schofield, Printer, 105 Summer Street.

This is a small book originally prepared for the use of the students of the Massachusetts Institute of Technology and now offered to the public. It consists of chapters on Instruments and their Uses; Geometrical Problems; Inking and Tinting; Projections and Notation; Shadows; Isometrical Drawing; Oblique Projections; Working Drawings and Examples.

The directions are very clearly given, and the selection of geometrical problems is excellent. It is a very good introduction to the study of mechanical drawing, but its value would be very much increased if more space was devoted to the practical application of the principles explained. Only six pages and a few rather meager and conventional plates have been devoted to this portion of he subject.

A TEXT-BOOK ON ROOFS AND BRIDGES. PART I: STRESSES IN SIMPLE TRUSSES: BY MANSFIELD MERRIMAN, PROFESSOR OF CIVIL ENGINEERING IN THE LEHIGH UNIVERSITY. New York; John Wiley & Sons (pp. 118; price, $2.50).

It is stated in the preface that this work constitutes a part of the course in civil engineering in Lehigh University. It covers the ordinary ground of line structures for bridges and roofs, and treats of the common forms of these structures now in use. The articles are short, each containing numerical examples involving the principles discussed in the previous pages. It is a very good work for class-room drill. The more difficult problems for the student, such as Double Systems, Lateral Bracing and Economic Depths, are brief. The Author has not exhibited his well-known ability for analyzing difficult problems, but has kept himself well down to the level of the undergraduate student. The details of those structures, the most-difficult part of the general problem of designs, are not considered in this work, but, as stated by the Author, will be treated later in the course.

ZWICKER'S INSTRUCTOR FOR STATIONARY AND STEAM ENGINEERS' LICENSE: BY PHILIP HENRY ZWICKER, PRACTICAL ENGINEER AND MACHINIST. St. Louis, Mo.; published by the Author.

This is a little book by an author whose chief qualification for the work he has undertaken is that he has had practical experience. From the book it would be safe to draw the inference that he has had more experience as a practical engineer than he has had in authorship. The book is extremely crude, the directions often far from clear, and rules of grammar are often disregarded. Thus, to the question, "What is an injector or inspirator?" we have the answer: "They *are* a device to answer for a pump in feeding a boiler." "What *is* the best gauge-cocks?" is another error that a proof-reader should have corrected if the Author did not. Caulking is spelled "corking," and to the question "Which is the hottest, steam or water?" we have the answer: "They are the same, only water will retain the heat longer, as water is a body and steam a vapor."

The book contains information of different kinds which,

perhaps, may be valuable to some practical men, but it is of the most elementary sort.

AMERICAN STREET RAILWAYS: THEIR CONSTRUCTION, EQUIPMENT, AND MAINTENANCE: BY AUGUSTINE W. WRIGHT, CONSULTING ENGINEER. Chicago and New York; Rand, McNally & Co.

Mr. Wright, who has had many years' experience in the construction and management of street railroads, has written and published the first book which embodies the results of American practice on this class of roads. He has done engineers and others interested in such work a service, for the only sources of information heretofore have been scattered articles and reports, which were accessible only with difficulty, if at all.

The book includes chapters on Track Construction; Paving; Track Cleaning; Equipment; Buildings, including stables, car-houses, etc.; and Management. An appendix contains calculations, based on experience, on the amount of horse-power used in propelling street cars.

Mr. Wright's book refers entirely to horse railroads, and he does not treat of cable roads, electric motors, or other devices for superseding horse-power. It is practical and is based on experience, and will doubtless be of much service to those for whom it is written.

How large this interest is may be appreciated when it is stated that there are in the United States nearly 6,000 miles of street railroad, on which some 22,000 cars and over 100,000 horses are in service.

NOTES ON THE COMPRESSIVE RESISTANCE OF FREE-STONE, BRICK PIERS, HYDRAULIC CEMENTS, MORTARS, AND CONCRETES: BY Q. A. GILLMORE, PH.D., COLONEL CORPS OF ENGINEERS, BREVET MAJOR-GENERAL, U.S.A. New York; John Wiley & Sons, 15 Astor Place (price, $3.50).

This latest work of General Gillmore appears almost simultaneously with the announcement of his death. Like all his published works in this direction, it derives great value from his known care and accuracy in experimenting and from his quickness and ability in generalizing and deriving results. The present book is chiefly devoted to a number of tests of building material and cements, made with the assistance of the great testing machine built at Watertown Arsenal for the Government by Mr. A. H. Emery some years ago. The opening chapters are occupied by some historical accounts of the investigations previously made for ascertaining the nature and strength of building stones, and by a careful description of the methods of making tests and of preparing the specimens.

The special series described included tests of Haverstraw free-stone and several different kinds of cements and mortars. A very interesting chapter is devoted to tests of brick piers, with the phenomena attending their breakage; those described in the present book were a continuation of a series made at the Watertown Arsenal some time previously. The results of all the tests are very fully and completely tabulated in an appendix, and are illustrated by strain-sheets and diagrams. With regard to the much-vexed question of cement tests the work is very complete, and adds some interesting facts to the knowledge already acquired on this subject. The results of these tests are summed up as follows:

"1. Mortars are generally not as strong as the concretes made with those mortars.

"2. The sets of mortars and concretes richest in cement proved stronger than the others.

"3. The smallest (4-in.) cubes in each of the four sets were decidedly the strongest of the lot.

"4. There is no apparent law of increase or decrease of strength per square inch of bed-area as the size of cubes increases."

In conclusion the Author suggests a further series of tests to ascertain not only the compressive strength, but the elasticity and other qualities of the best-known cements; and also that parallel tests should be carried on by repetition of loads below the crushing load in order to ascertain the existence of a law by which it may be possible to discover the maximum load which can alternately be put on and taken off without injury. He also suggests a trial of the effect of weights falling from certain heights upon material whose resistance both under steady pressure and also under repeated loads is known.

PHOTOGRAPHY APPLIED TO SURVEYING: BY LIEUTENANT HENRY A. REED, U.S.A., ASSISTANT PROFESSOR OF DRAWING, U. S. MILITARY ACADEMY, WEST POINT, N. Y. New York; published by John Wiley & Sons, 15 Astor Place.

This is a clear, explicit, and interesting description and explanation of the application of Photography to Plane and Topographical Surveying.

The subject is one to which very little attention has been paid in this country, as the Author remarks in his preface, and its advantages, both as to rapidity and accuracy of work, are very little understood.

The Introduction contains an historical sketch, showing the improvements and advances which have been made from time to time in the instruments and methods used, with also a brief but clear statement of the general principles upon which is based the construction of plans from perspectives or photographs, being the reverse of the ordinary methods of making perspectives from plans with the elevations.

The Methods of Plane Perspectives follow, with a full description of instruments, materials, and manner of work. In this method the ordinary photographic camera can be used, one or two slight and inexpensive additions being made to facilitate the work, but these are not an absolute necessity. The methods both in the field and office are so clearly explained that only a very slight knowledge of surveying or photography is necessary in order to conduct the work.

The more advanced methods are then discussed, including cylindric perspectives, radial perspectives, and the camera without a lens. In these methods specially constructed instruments are used, and the results obtained are in every way more satisfactory.

A full description of the various instruments, with the method of use in the field and plotting in the office from the photographs, is given. There is an interesting and instructive chapter on Telescopic and Balloon Photography, showing the great advantages it possesses for military reconnoissance, etc. The book closes with a detailed account of the various applications of photographic surveying and some of its advantages. Certainly its advantages are many, and much time and money would be saved by its more general adoption.

It is of almost universal application, from the survey of the ordinary farm up to the finest and most detailed topographical map. As the Author says, "In no other way can such thoroughness of detail be obtained, and in the end we have not only an accurate topographical map, but also photographs of the section surveyed which present to the eye natural views of this section.

"These, taken in connection with the map, often make possible the location of engineering works of any description without the necessity of an actual examination of the ground."

Lieutenant Reed treats the entire subject in a most clear and concise manner, and the book is one which will well repay a careful study by any persons interested in the subject, either as professionals or amateurs.

BOOKS RECEIVED.

HARPER'S WEEKLY for April 21 contains a large double-page plate showing all the new vessels now under construction for the United States Navy. The plate, of course, gives only an outside view, showing the general appearance the ships will have when completed, and not illustrating further the special features of their construction. It includes 16 vessels, varying in size from the great armored cruiser *Maine* to the little torpedo boat not much larger than a first-class launch. It is of interest as showing the wide departure of the new from the old Navy.

In the POPULAR SCIENCE MONTHLY for May there will be published an article by Mr. Arnold Burges Johnson on Sound Signals at Sea. In this article will be described a number of new and ingenious devices for communication between ships and to give warning of the nearness of and direction of dangerous objects.

In SCRIBNER'S MAGAZINE for June, it is announced, will be begun the publication of the series of illustrated articles on Railroads of which some reference has heretofore been made. The first article will be on the Building of a Railroad, and will be by Thomas Curtis Clarke, the well-known engineer. He will describe briefly the process of locating and building a railroad from the first preliminary reconnoissance to the final laying of the track. Other articles of the series so far announced are: Engineering Feats, by John Bogart; Locomotives and Cars, by M. N. Forney; Passenger Travel, by Horace Porter; Railroad Employés' Life, by B. B. Adams.

ETUDE GENERALE SUR LES MARTEAUX-PILONS: PAR C. CHOMIENNE, INGENIEUR DES FORGES DE L. ARBEL, RIVE-DE-GIER, LOIRE, FRANCE. Paris; Imprimerie Chaix. This is the paper which this year received the first prize of the Society of Graduates of the National Schools of Art and Trades at Paris.

PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE: VOLUME XIV. Annapolis, Md.; published by the Institute.

PROCEEDINGS OF THE MICHIGAN ENGINEERING SOCIETY AT ITS SEVENTH AND EIGHTH ANNUAL CONVENTIONS (1886 and 1887). Kalamazoo, Mich.; published for the Society.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present issue includes the following papers: Discharge of Rivers, by Professor A. R. Harlacher and H. Richter; Electrical Tramways, by Edward Hopkinson; Hydraulic Appliances at the Forth Bridge Works, by Ernest William Moir; Engineering Laboratories of the Massachusetts Institute of Technology, by Professor Gaetano Lanza; Locomotives and Rolling Stock of the Bengal & Northwestern Railway; the Sulina Mouth of the Danube, by Charles Henry Leopold Kühl; the Government Testing Works at Malines, Belgium, by E. J. Roussel.

TRANSACTIONS OF THE ARKANSAS SOCIETY OF ENGINEERS, ARCHITECTS, AND SURVEYORS: VOLUME I, NOVEMBER, 1887. Little Rock, Ark.; published by the Society.

JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, VOLUME II, NUMBER 3. Published by the Board of Editors; Secretary's Office, New Bedford, Mass.

FIFTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF KANSAS, FOR THE YEAR 1887: JAMES HUMPHREY, ALMERIN GILLETTE, AND A. R. GREENE, COMMISSIONERS. Topeka, Kan.; State Printer.

REVISTA DE OBRAS PUBLICAS E MINAS: PUBLICACAO MENSAL DA ASSOCIACAO DOS ENGENHEIROS CIVIS PORTUGUEZES. Lisbon, Portugal; National Printing House.

A TREATISE ON ARTIFICIAL REFRIGERATION. New York; issued by the Consolidated Refrigerating Company. This is a well-illustrated description of the system of artificial refrigeration adopted by the company named above, and now in practical operation.

TRUE INWARDNESS: BY AN HONEST MAN. Newton, Mass.; Sterling Elliott. This is not only an admirable specimen of typographic and artistic work, but it is also the most original and witty specimen of a catalogue we have ever seen. Works of that kind are usually very dry reading, but this is one which will not only take the eye of the reader, but will command his attention. It is useless to attempt a description of its contents; the book must be seen to be appreciated.

ILLUSTRATED CATALOGUE OF THE BROWN & SHARPE MANUFACTURING COMPANY. Providence, R. I.; issued by the Company. This catalogue is issued in a neat and compact form, the size (5½ by 3¼ in.) being such that it can be carried in the pocket and will take but little room on a desk. In its 175 pages is a full list of the wide range of machine tools and of the numerous gauges and other tools for accurate measurement manufactured by the Company. A great convenience which should be found in all catalogues of this kind, but is often omitted, is a full index of the contents.

LANSING IRON & ENGINE WORKS: CATALOGUE OF MILL SUPPLIES. Lansing, Mich.; issued by the Company.

SOMETHING ABOUT CULVERT PIPE: ITS MATERIAL, ITS MANUFACTURE, ITS USES. St. Louis; Blackmer & Post, Equitable Building.

KEYSTONE STEAM PUMP WORKS: CATALOGUE. Pittsburgh, Pa.; Epping, Carpenter & Company, Limited.

THE KORTING GAS ENGINE: CATALOGUE. New York; issued by the Korting Gas Engine Company, Limited.

CORRUGATED AND OTHER SHEET METAL BUILDING MATERIAL: CATALOGUE. Issued by the Cincinnati Corrugating Company, Cincinnati, O.

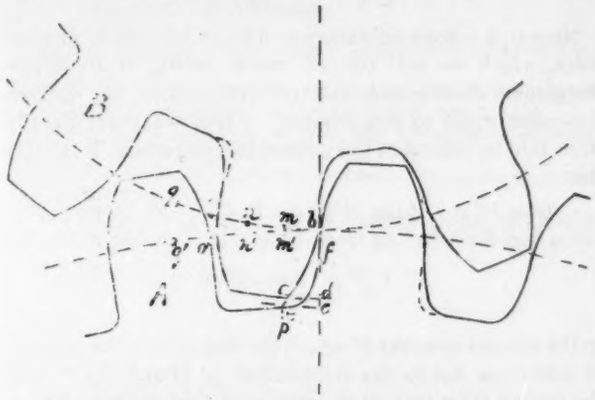
Contributions.

Clearance Curves for Gear-Teeth.

To the Editor of the Railroad and Engineering Journal:

In the discussions of the shapes of gear-teeth given by writers on mechanics, it will be found that no definite instructions are given relative to the curves connecting the flanks of the teeth with the rim of the wheel or the clearance curves. In heavy gearing, transmitting large powers, this may be an important point, for the shapes of these curves may modify considerably the strength of the teeth.

The figure herewith illustrates the so-called radial-flank epicycloidal tooth. The usual method of connecting the



flanks to the rim is by a fillet whose radius is chosen small enough to insure ample clearance for the points of the teeth of the mate gear, as shown by the teeth *A* and *B*.

A better method, to which attention is called, is the following: Having determined the proper curve *a b* for the point of the tooth, mark a point *p* on this curve, at a distance beyond the extreme outside of the tooth equal to the radial clearance *c d* of the gears. Then find the path *e f* that this point would describe on the other gear when the teeth are in action. This path may be easily determined in the following way: Lay off a number of equal distances, *m n o q*, *m' n' o' q'*, on the pitch circles from their intersection, *b*. With the distances *mq*, *nq*, *oq*, etc., as radii, describe arcs from the points *m'*, *n'*, *o'*, etc. The curve tangent to all these arcs will be the required clearance curve. It will be seen that this is a more rational way than has been usual of determining the shape of this part of a gear-tooth, and it will generally be found that this curve increases the strength of the tooth.

This method may be applied to any of the various forms of teeth in use. It was devised by the writer and applied to some very large gears in about the year 1871, but so far as known to him, has not been published before, although it has been used a good deal by others.

A. K. Mansfield.

No. 280 Broadway, New York.

STRESS IN CONTINUOUS FRAMED GIRDERS.

By J. Hiroi.

It is a well-known fact among engineers that the discussion on stresses in continuous girders has been a subject, especially in America, of comparatively little interest to practical men, and it is almost such, that were it not for the necessity of constructing drawbridges and for some daring works like those of the Kentucky River, Minnehaha, and Lachine bridges calling the attention of the engineering public, few would even take any notice of the subject. Some look upon those long series of formulæ which characterize the calculation of stresses in continuous girders with a sort of suspicion, while eager beginners try to catch the first opportunity of making use of the Clapeyronian formula, calculating reactions to a single pound, more often forgetting the fact that the formula as ordinarily given is only applicable under very restricted conditions—viz.:

1. When the modulus of elasticity is a constant throughout the girder.

2. When the moment of inertia of a section of the girder is constant everywhere.

3. When the supports are of such height that the neutral axis of the girder is undeformed when the girder is weightless.

4. When the deflection of the beam is not very great.

5. When the girder has such a form that $d\,s = d\,x$, s being length along the neutral axis of the girder and x the horizontal.

6. When there is no deflection due to the deformation of the web.

How far all these conditions are fulfilled in ordinary cases every one can easily judge for himself.

One reason why the formula of continuous girders is looked upon with suspicion may in some cases be that most people—instead of stopping to think that a girder lying over more than two supports is nothing but a similar girder whose deflections, due to loading, are worked back so that at the points of support it occupies the original position of unstrained girder—merely look at the formula, whose derivation is not, of course, so simple as the mere principle of a lever.

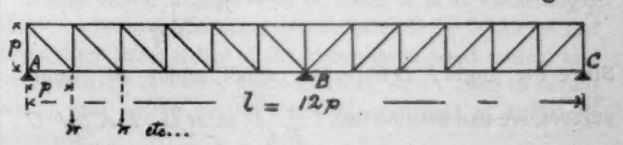
The first three conditions mentioned need not be fulfilled in the theorem of three moments in an extended shape. Weyrauch has given a very complete solution for such cases in his "Theorie der Einfachen und Continuirichen Träger."

The fourth and fifth conditions are generally fulfilled in ordinary bridges.

The sixth, which is usually neglected, will be here taken up, to show what difference this neglect gives to the calculated stresses in continuous framed girders. A straight framed girder over three level points of support will be taken, the girder being merely supported at the ends.

To make the calculation plainer, instead of using the Clapeyronian formula, the girder, as already said, will be considered as a simple girder whose deflection at the middle point is restored to its unstrained condition. That this involves the same principle as the Clapeyronian formula—viz., the equation of the elastic line, is evident to any one who has studied the subject.

Let the truss have its members as shown in the diagram,



and let each panel point be loaded with an equal weight *W*. Further, let the girder have constant cross-section throughout.

Then, on the supposition that the support B does not exist, we obtain the amount of deflection at the point due to the deformation of chords by the ordinary formula of deflection :

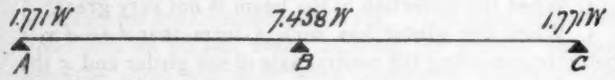
$$\delta = \frac{1}{24\,I\,E} \overset{a}{\underset{0}{\Sigma}} W a\,(3\,l^2 - 4\,a^2) = \frac{6444\ W p^3}{24\,I\,E}.$$

Now, in order to undo this deflection, or, in other words, to put in at B an immovable support level with end ones, an upward reaction must be exerted at B, which can deflect the girder at that point by the same amount as δ. Let P be such reaction. Then we have at once from the formula of deflection, with load at the middle :

$$\frac{P\,l^3}{48\,E\,I} = \delta = \frac{6444\ W p^3}{24\,I\,E},$$

from which $P = 7.458\ W$.

Consequently we obtain the following reactions, exactly the same as obtained from the theorem of three moments, as it should be.



This gives the moment at B to be equal to

$$1.771\ W \times 6\,p - W\,p\,(5 + 4 + 3 + 2 + 1) = -\,4.374\ W\,p.$$

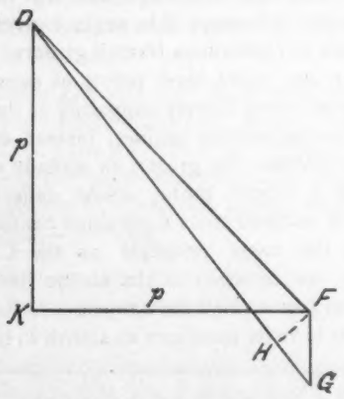
We will now see what difference will be brought about in reactions and moment when the deflections due to the deformation of web-members are taken into consideration. For simplicity's sake we will assume that the chord and each web-member have a constant cross-section C.

The deflection due to weights W, once more under the supposition that the girder is supported at A and C only, is :

from verticals : $\Sigma \frac{p\ s}{E\,C}$, in which s represents the stress acting in several verticals, and E = mod. of elasticity as before.

$$\Sigma \frac{p\,s}{E\,C} = \frac{p\ W}{E\,C}(.5 + 1.5 + 2.5 + 3.5 + 4.5 + 5.5) = \frac{18\ W\,p}{E\,C}$$

from diagonals, since the original length $D\,F$ is equal to $\sqrt{2\,p^2}$ its elongation is $\frac{s^1\sqrt{2\,p^2}}{E\,c}$, when s^1 is the stress.



Since the angle $F\,D\,G$ is very small under all circumstances, we can assume that $\frac{s^1\sqrt{2\,p^2}}{E\,C} = H\,G : D\,K :: F\,G : D\,F$, from which $F\,G = \frac{s^1\sqrt{2\,p^2}}{E\,c} \times \sqrt{2\,p^2} \times \frac{1}{p} = \frac{2\,s^1\,p}{E\,C}$, and hence the deflection $= \Sigma \frac{2\,s^1\,p}{E\,C}$

$$\Sigma \frac{2\,s^1\,p}{E\,C} = \frac{2\,p\ W}{E\,C}\,(.5 + 1.5 + 2.5 + 3.5 + 4.5 + 5.5)\ \text{Sec. } 45^\circ$$

$$= \frac{50.9\ W\,p}{E\,C}.$$

Consequently the total supposed deflection at the point B due to the deformation of the web is

$$\frac{18\ W\,p}{E\,C} + \frac{50.9\ W\,p}{E\,C} = \frac{68.9\ W\,p}{E\,C}.$$

This, added to the deflection due to the deformation of chords, as already found, gives the total of

$$\frac{68.9\ W\,p}{E\,C} + \frac{6444\ W\,p^3}{24\,I\,E}.$$

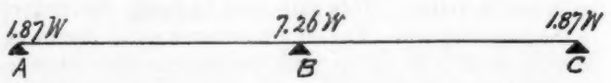
Now it is merely necessary to find the amount of upward force, which we will call P^1, which, acting at B, deform the girder, chords, and web both, to produce the upward deflection equal to this amount. From what has already been said in regard to the downward deflection, it is clear that

$$\frac{68.9\ W\,p}{E\,C} + \frac{6444\ W\,p^3}{24\ I\,E} = \frac{P^1\,l^3}{48\,I\,E} + \frac{P^1}{2} \cdot \frac{6\,p}{C\,E} + \frac{6\,P^1\,p \cdot \text{Sec. } 45^\circ}{C\,E},$$

in the second member of which the first term is the amount of deflection due to the deformation of chords by P^1, and the second term that of the verticals ; and the last, that of the diagonals both due to the shearing $\frac{P^1}{2}$. From the assumption we have made $I = \frac{C\,p^2}{2}$; consequently we obtain at once from the above equation

$$P^1 = 7.26\ W.$$

Thus we have new reactions as follows :



The bending moment at B now becomes

$$1.87\ W \times 6\,p - W\,p\,(5 + 4 + 3 + 2 + 1) = -\,3.78\ W\,p.$$

These figures show that by taking the deflection due to the deformation of web-members we obtain at end supports the increase of reaction of $\frac{1.87 - 1.771}{1.771} = 6$ per cent.; at the middle support the decrease of reaction of $\frac{7.458 - 7.26}{7.458} = 2\frac{1}{2}$ per cent., and the decrease of moment of $\frac{4.374 - 3.78}{4.374} = 13\frac{1}{2}$ per cent. from what the ordinary calculation gives.

These are true only under the assumptions we have made and for the girder we have taken as an example. Every other case will have its own variations of stresses corrected for the deformation of web-members ; and the above merely indicates the simple method of procedure for calculation. In plate-girders the deflection contributed by the web is almost inconsiderable, and the ordinary formula applies with correctness sufficient for all practical purposes.

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

(Copyright, 1887, by M. N. Forney.)

(*Continued from page* 159.)

CHAPTER XVIII.

OFFICE WORK.

In plotting the notes, both in the field and in the office, when the maps are to be finished up, the following rules, taken, to a great extent, from the *Instructions* of the Chief Engineer of the Atchison, Topeka & Santa Fé Railroad, may be followed with advantage:

All lines should be clear, uniform, and distinct, avoiding hair lines.

The only ink used should be well-ground India ink, except where time may be more of an object than finished plans.

When prepared ink is to be used, the photo-black drawing ink of Keuffel & Esser is the best.

All figures and notes on the map should invariably be in the same black ink.

The line of the survey should be drawn in some chemically opaque red, such as would result from the admixture of good cake carmine and cadmium. The P. Cs. and P. Ts. should be shown, and also the length of the radii of the curves put on in figures.

Colored ink should never be used, especially upon tracings.

Gamboge should never be used either alone or in any combination.

All tracing should be done on the rough or unglazed side of the linen.

On every map or drawing, as near the left-land lower corner as possible, should be written distinctly the title, scale, and date of execution.

When maps are to be highly finished and are for exhibition before a board of directors or other men who are not engineers, it is admissible to use an elaborate finish, but in all cases where they are for the use of engineers, and are not for show, the lettering, etc., should be as plain and distinct as possible, and without any unnecessary work. The best form of lettering for notes, etc., is what is called "stump" writing, and it will well repay any engineer to practise this style of writing until he can do it with speed and neatness. For titles, what is called "round" writing is by far the best, as it is very neat, and with a little practice can be done with great speed.

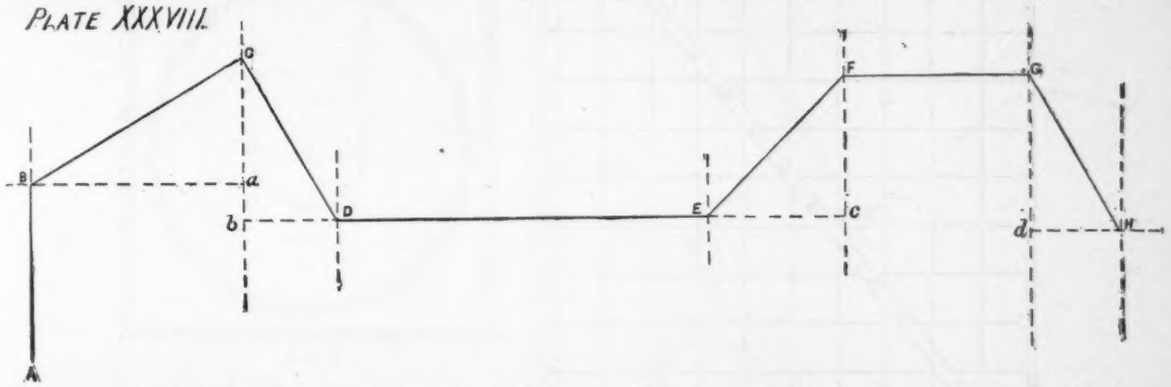
The small metal protractors which come with instruments are absolutely worthless. The only protractors which should be used in the field are paper protractors, and in the office either paper protractors or large and expensive metal ones with micrometer adjustments.

On contour maps the contour lines should be put in in some color other than black. Different shades of brown are the best. Every fifth line should be noticeably heavier than the others, and should have its height distinctly written upon it in a sufficient number of places to make it always easy to find. Unless contour maps are made in this way they are worse than worthless, and all the time spent in the field collecting the data has been wasted. Plates XXIX and XXX are good illustrations of contour maps, and are copies of work actually done in the field.

When a long, broken line is to be plotted the most accurate manner of doing the work is by means of "Latitudes and Departures." Suppose we have the broken line *A B C D*, etc. (Plate XXXVIII), the different straight lines of which it is composed meeting at the angles noted on the plate. We will suppose *A B* is a north-and-south line, and we draw it vertically on the paper and scale off its proper length.

We have the angle *C B a* and the length of the line *B C*. We then find the distance *B a*, which is the cosine of the angle *C B a*, and is called the departure of the point *C*. Lay off this distance on a horizontal line through *B*. Then find the distance *C a*, which is called the latitude of the point *C*, and is also the sine of the angle *C B a*, and lay it off on a vertical line drawn through *a*; this gives the exact location of the point *C*; then connect *C* and *B*.

PLATE XXXVIII.



We then proceed in the same manner with the point *D E F*, etc., every point being located by means of one vertical and one horizontal line.

In cases where the line has been run by means of the needle, so that we have the magnetic bearings of each line, they are all referred to a north-and-south line, and the latitudes and departures calculated at once. When the line has been run by means of the angles of intersection, a north-and-south line is drawn on the paper, and the angles which all these short lines *A B*, *B C*, *C D*, etc., make with this line are calculated, and then the latitudes and departures worked from these.

The latitudes and departures may be taken directly from tables prepared for that purpose, called "Traverse Tables," or from tables of natural or logarithmic sines and cosines. These last are by far the more accurate, as the angles can be taken to each minute, while the ordinary traverse table only reads to every 15 minutes.

Where much work has to be done, it is an exceedingly slow and tedious operation to calculate all the latitudes and departures from either of the above-mentioned tables, and the following is a very rapid method, much used in actual work, and where proper care is exercised of sufficient accuracy.

Plate XXXIX represents what might be called a "Graphic Traverse Table," as manufactured by Keuffel & Esser, of New York. It consists of a sheet of tin about 18 in. square, divided by horizontal and vertical lines to any convenient scale, say one-tenth or one-twentieth of an

inch, as shown at *a b c*. Outside of this square and near the edge of the plate there is a protractor, *e f g*. *D T* is a straight-edge, one edge of which is divided into exactly the same scale as the plate. This straight-edge turns on a pivot at *P*, which is the point of intersection of the two sides of the square *h c* and *i a*. The side of the straight-edge upon which is the scale is in line with this point of intersection *P*.

The manner of use is as follows :

The straight-edge *D T* is set at the angle of departure by means of the protractor *e f g*. The length of the line is taken on the scale on the ruler, and the point where this comes on the plate noted. Then by reading off the distance of this point from the line *c h* upon the line *a i*, we have the latitude of the point, and by reading off its distance from the line *a i* upon the line *h c*, we have the departure.

For example, we have a line 100 ft. long with an angle of departure of 78°. Set the ruler at 78°, and note the position of the point 100 on the scale, which comes at the point *l*. Then we have the position of the point *l* on the scale *a i*, or its latitude, 78.8, and its departure or distance on the scale *h c* as 61.5+.

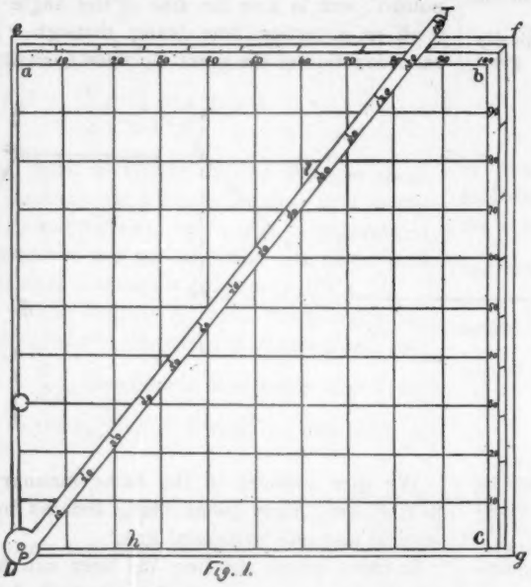


Fig. 1.

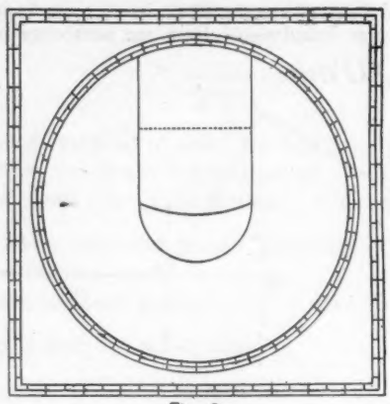


Fig. 2.

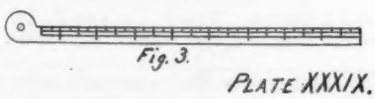


Fig. 3.

PLATE XXXIX.

It takes two persons to calculate latitudes and departures by this method with rapidity and accuracy, one to read off the angles and distances and note the results, while the other manipulates the diagram and reads the results. One of the diagrams can be easily made by using a piece of cross-section paper and a paper scale, using care to have the zero on the paper scale at the point *P*, about which it turns.

The advantages of plotting a line of survey by means of latitudes and departures are the greater accuracy obtained and the less liability to error ; also the fact that any error that is made in plotting one line is confined to that line, or, at any rate, does not grow larger as the work advances, from the fact that each line is plotted not from the one which preceded it, but from parallel lines. The direction of each line is thus made entirely independent of what has gone before.

CHAPTER XIX.

CURVES.

As we have said before, the preliminary lines of a railroad survey are broken lines ; that is, they are made up of straight lines of greater or less length, forming different angles at their points of intersection, as shown in Plate XL, fig. 1.

On the final or permanent line of the railroad (the center line upon which it is built), all these angles are rounded off by means of curves of various radii, as shown in Plate XL, fig. 2. The usual curve is an arc of a circle, although in one case (the Festiniog Narrow Gauge Railroad in Wales) a parabolic curve has been used as being the theoretically correct curve ; that is, the curve which opposes the minimum resistance to the passage of a train.

Even this theory, however, is acknowledged to be inaccurate as to the actual resistance encountered by the train ; and another great objection to the general adoption of the parabola is the difficulties which occur in running in the curve. The curve which theoretically presents the least difficulty, both in laying out and in hauling trains around it, is a circular curve, with the ends eased off by one or the other of the different methods extant.

The subject of easing off the ends of curves, or, as it is termed, putting in "transition curves," will be taken up later. We will now take up only circular curves, showing the principles upon which their use is based ; the manner of calculating them ; the manner of laying them off in the field, with explanations of a few of the problems which occur with the greatest frequency in practice. For a full and elaborate treatise on the subject of railroad curves and all pertaining thereto, the reader is referred to the book on that subject by John C. Trautwine as being one of the best that is published, and also to Searles's "Field Engineering." Before explaining the manner of laying out curves in the field, we wish to call attention to a few definitions which the reader will do well to get firmly fixed in his memory.

In Plate XLI, fig. 1, let *A D C* and *B E C* represent two tangents or two parts of a preliminary line meeting at an angle at *C*. Then the angle *m C E* is called the angle of intersection. It is required to join these two tangents by a circular curve of any given radius. Let *D g h i k E* represent this curve and *F* the center of the curve ; then *D F* or *E F* is the radius of the curve.

The curve commences at *D* on the tangent *A D C*, which point *D* is called the "Point of Curve," and in the notes is designated by the letters "P. C."

The curve ends at *E* on the tangent *B E C*, which is

called the " Point of Tangent," and designated by the letters " P. T."

The distance from the angle of intersection C to the point D, where the curve begins, and the point E, where it ends, is called the " tangential distance."

The angle $D\,F\,E$ included between the radii $D\,F$ and $E\,F$, drawn from the points D and E or P. C. and P. T. of the curve is called the " Central Angle" of the curve, and is always equal to the angle of intersection $m\,C\,E$. The central angle is designated in the notes by " Δ."

A Chord is a straight line, shorter than the diameter of a circle, joining any two points in its circumference, as the line $i\,k$ or the line $D\,k$.

The Length of a curve is not measured exactly on its circumference, but by chords one station long. Thus, when a chain 100 ft. long is used, a curve is said to be, say, 700 ft. long when it contains seven stations of 100 ft. each, measured by chords 100 ft. long.

This measurement does not, of course, give the exact length of the curve, but always a little less, and the shorter the radius of the curve the greater the difference between the actual length and the length given by means of 100-ft. chords. But until the radius becomes less than 600 ft. the difference between the actual length and the length obtained by measuring with a 100-ft. chain is so small that it may be disregarded.

When the radius is less than 600 ft. the curve should be measured by chords of 50 ft. in length, and where the radius is less than 300 ft. by chords of 25 ft.

In speaking of railroad curves they are designated as curves of a certain number of degrees. Thus, a 6-degree curve, an 8-degree curve, etc.

By the degree of a curve is meant the central angle, which is subtended by a chord one station long (100 ft., or 20 meters, as the case may be).

Thus in Plate XLI, fig. 1, let $D\,g$ represent a chord 100 ft. long. Then the number of degrees and minutes in the angle $D\,F\,g$ subtended by this chord is the degree of the curve.*

* The common practice among English engineers is to take the radii of the curves a full number of feet, and then calculate the degree of curve. American engineers, on the contrary, usually take the degrees or the minutes, and calculate the radii.

To lay out a curve on the ground we must know the P. C. or starting point and the degree of curvature D. The length of the curve L is either calculated, as when two existing tangents are to be connected by it and the P. T. is known, or the P. T. is decided upon as the curve is fitted to the ground and the desirable direction of the next tangent becomes obvious.

The distance $k\,c$ is called the " External Distance." It is the distance from the point of intersection of the tangent to the middle point of the curve.

The long chord is a straight line joining the P. C. and P. T.

The following letters will be used to designate the various elements of the curve opposite them.

Δ = Central angle, $D\,F\,E$, m C E.
D = Degree of curve.
L = Length of curve in stations.
R = Radius.
T = Tangent distance $D\,C$ or $C\,E$.
C = Long chord $D\,E$.

PLATE XL.

FIG. 1.

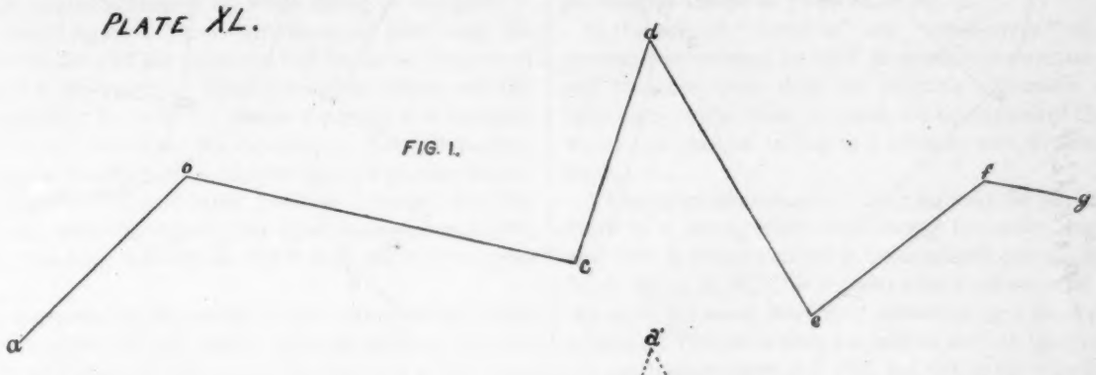
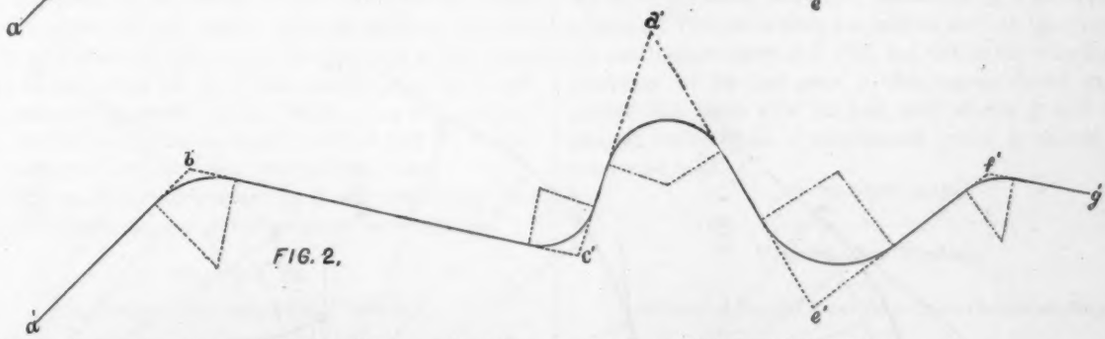


FIG. 2.



M = Middle ordinate $K\,O$.
PC = Point of curve, D.
PT = Point of tangent, E.

The following are some of the problems which occur in actual work with the greatest frequency :

(1) $L = \frac{\Delta}{D}$ (2) $\Delta = D\,L$ (3) $D = \frac{\Delta}{L}$

(4) $T = R$ tang. $\frac{1}{2}\,\Delta$ (5) $C = 2\,R \sin \frac{1}{2}\,\Delta$
(6) $M = R$ vers. $\frac{1}{2}\,\Delta$ (7) $E = R$ external sec. $\frac{1}{2}\,\Delta$
(8) $R = T$ cot. $\frac{1}{2}\,\Delta$ (9) $E = T$ tang. $\frac{1}{4}\,\Delta$
(10) $R = \frac{E}{\text{Ex. sec. } \frac{1}{2}\,\Delta}$ (11) $T = E$ cot. $\frac{1}{4}\,\Delta$

The above equations are taken from Searles's " Field Engineering," and present the simplest manner of calculating the different elements of the curve. In order to use these equations, of course, a table of sines, tangents, etc., is necessary ; but as all engineering pocket-books contain these, they are, or should be, always at hand for use.

However, the student will see, upon a little study, that most of the above problems can be worked out by means of the properties of right-angled triangles.

We now come to the methods used in the field in putting the curve on the ground, Plate XLI, fig. 2.

Let *A B* be the tangent and *B* the point of curve, P. C.; the degree of curvature *D* has been decided upon. Set the transit up at *B*, with the zeros of the two plates together. Then sight back on the tangent to some point *A*, and set the telescope on it. Reverse the telescope, and we are ready to commence the curve.

The stakes are to be put in every station. Turn off the angle *o B c* equal to $\frac{1}{2}$ the angle of the curve, $\frac{1}{2}$ *D* and line in the point *c* one station from *B*. This angle *o B c* is called the tangential angle. Move the transit to *c*, place the zeroes together, and sight back on *B*. Then reverse the telescope and turn off the full angle of the curve *m c d* or twice *A b c* and line in the point *d*, one station from *c*.

Proceed in a like manner to establish the points *e* and *T*.

PLATE XLII.

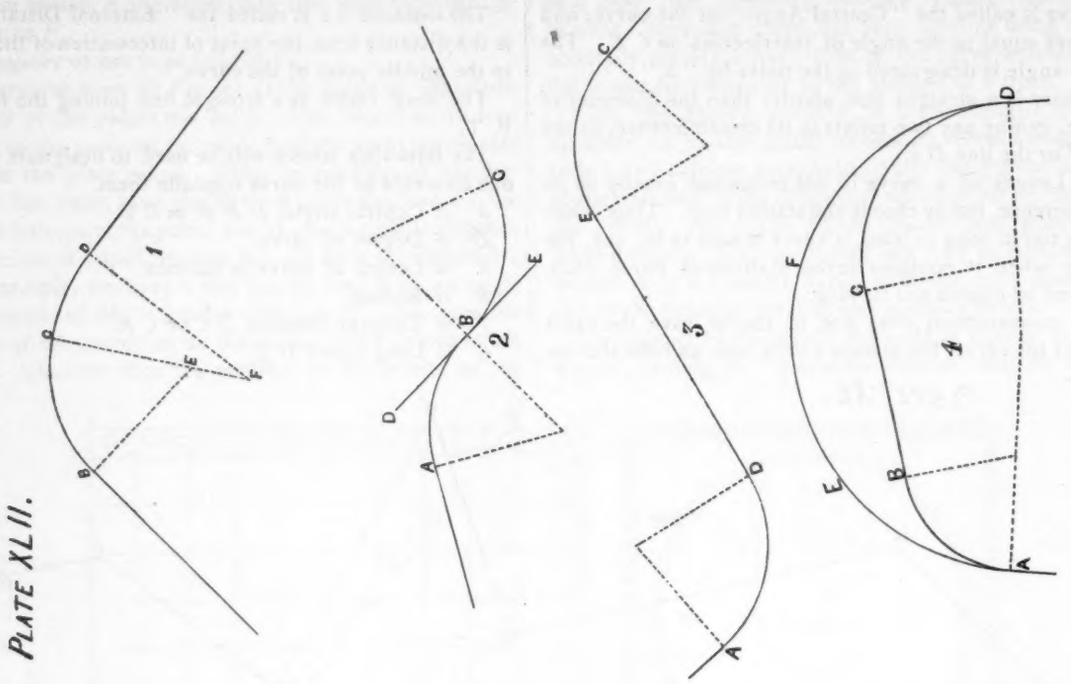
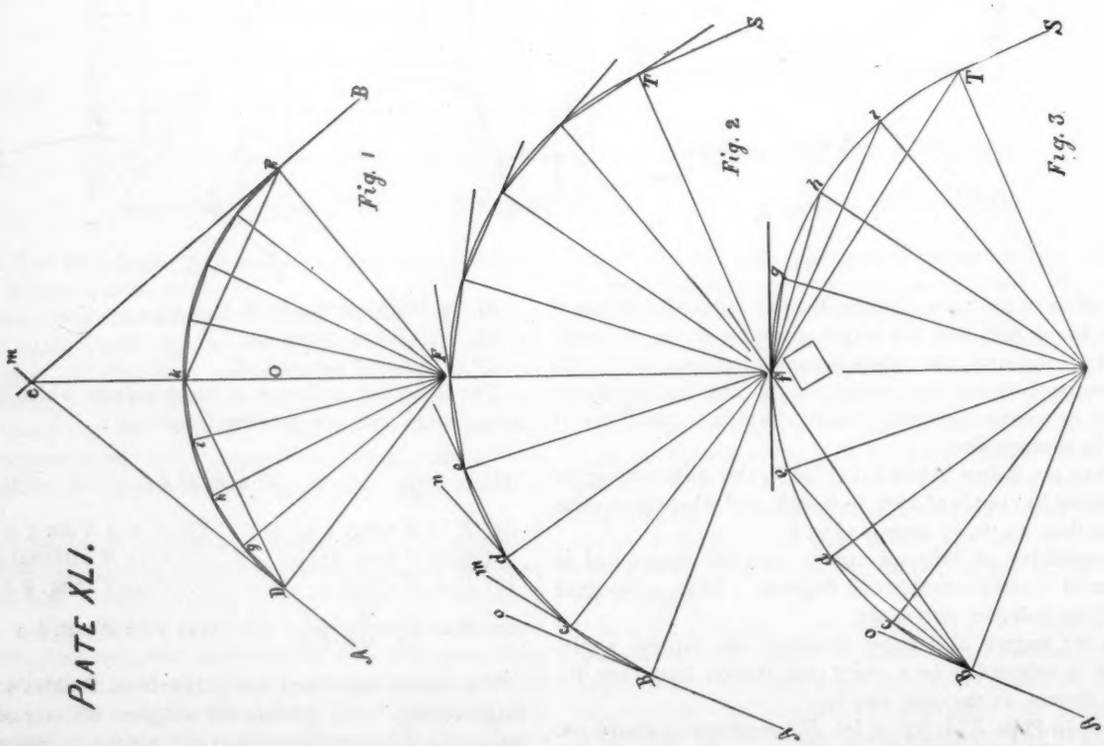


PLATE XLI.



T represents the point of tangent. In order to pass from the curve to the tangent, set the transit at *T*, sight back on *e*, reverse the telescope, and then turn off the angle *T* equal to $\frac{1}{2}$ *D*, and it will give the direction of the new tangent. In running in the curve the angles *m c d*, *n d e*,

etc., are called deflection angles, and are all equal to D. This method is called running in a curve by means of "deflection angles," and is used to a less extent than the following from the fact that, the transit having to be moved each station, much time is lost.

The second method for running in curves, and the one used whenever possible, is by means of tangential angles, and is as follows, Plate XLI, fig. 3.

Let $A\,B$ be a tangent and B the point of curve. Set the transit at B, with the zeroes together, and take a back sight at A. Reverse the telescope and turn off the angle $A\,B\,c$ equal to $\frac{1}{2}\,D$ and line in station c. Then turn off the angles $c\,B\,d$, $d\,B\,e$, $c\,B\,f$ in succession, each equal to $o\,B\,c$ (equal to $\frac{1}{2}\,D$), and line in the points $e\,f$, etc., and all these points will be upon the circumference of the required circle. In case the curve is not too long and there is no obstacle in the way, this process can be continued until T, the point of tangent, is reached. But if between B and g there is some obstacle, or the distance is so great that a good clear sight is impossible, then move the transit to f, with the plates clamped, as when lining in the point f. Take a back sight on B and turn the upper plate until the zeroes coincide, and the telescope will be on the tangent of the curve at the point f. Then proceed as before, and run in the points $g\ h\ i$ and T. When the point T is reached, and it is required to get the direction of the new tangent $T\,S$, proceed exactly as at f—that is, with the plates clamped at the angle $k\,f\,T$, and sight back on f, reverse the telescope, and turn the upper plate until the zeroes coincide, and the telescope will be on the line of the new tangent $T\,S$.

If at any point on the curve it is necessary to set intermediate stations at, say, half or quarter stations, then the angle to be turned off bears the same relation to the angle that would be turned off for a full station that the length of this sub-station bears to the length of a full station; that is, for half a station we would turn off half the angle; for a quarter of a station, one quarter the chord.

It very often happens that at both the beginning and ending of a curve the use of sub-stations is necessary.

CHAPTER XX.

COMPOUND AND REVERSED CURVES.

In order to fit the line better to the ground it is often necessary to use what are called COMPOUND CURVES—that is, a curve made up of any number of simple curves of different radii. Thus, in Plate XLII, fig. 1, $B\,C\,D$ is a compound curve, being composed of the curve $B\,C$ with the radius $B\,E$ and the curve $C\,D$ with the radius $F\,D$. In changing from a curve of one radius to one of another radius the point of compound curvature designated by the letters "P. C. C." must be a point where a tangent to one of the curves will also be tangent to the other, as the point C. In other words, the radii of two curves at their point of contact will coincide in all except length.

A REVERSED CURVE is composed of two curves of opposite direction that have a common tangent at the point where they meet, as shown in Plate XLII, fig. 2, where $A\,B\,C$ is a reversed curve, the line $D\ E$ being tangent to both at the point B, where they meet.

In practice reversed curves proper should never be used where it is possible to avoid it, owing to the fact that, the direction changing at once from right to left, or *vice versa*, it is impossible to give the outer rail of each or either curve the proper elevation. Either the change from the elevation of the rail on one side to that on the other must be made very abruptly, or a long distance on each curve will have insufficient elevation. As the ease and steadiness with which a train will pass around a curve depend to a great extent upon the correct superelevation being given to the outside rail, the great objection to reversed curves is due to the impossibility of doing this, and the consequent jarring and wrenching to which the rolling stock is subjected increases to a great extent the wear and tear on both rolling stock and road-bed, and therefore the cost of repairs and renewals.

The increased resistance to the passage of the train due to the change of direction in the curve amounts to very much less than has heretofore been calculated. Wherever it is necessary that the direction of the curve should change from one side to the other, there should always, when possible, be a piece of tangent of not less than 300 or 400 ft. introduced between them. This gives an opportunity for the train to straighten out and also for the change in the superelevation of the outside rail to be made in the proper manner, as shown in Plate XLII, fig. 3.

In the case of "turnouts" and "cross-overs," of course reverse curves must be used in order to economize space, and in those cases they are perfectly admissible and do little harm to the train, as, from the necessities of the case, trains are obliged to run at a reduced rate of speed over them.

There is another class of curves against the use of which there is a strong prejudice among the older engineers, and that is what is called a broken-back curve. In Plate XLII, fig. 4, $A\,B\,C\,D$ is a broken-back curve—that is, two curves in the same direction, connected by a short piece of tangent. The curve does not look as well on the ground as the continuous curve $A\,E\,F\,D$, but this is the only inherent objection to its use over a continuous curve that the author has been able to find, and where it will fit the ground better than a continuous curve it should by all means be used.

(TO BE CONTINUED.)

The Oschutz Viaduct.

(Translated from the *Revue Generale des Chemins de Fer.*)

THE railroad line, of standard gauge, from Mehlteuer to Weida, in Saxony, crosses the valley of the Oschutz by an iron viaduct, which has now been for some time in use by trains.

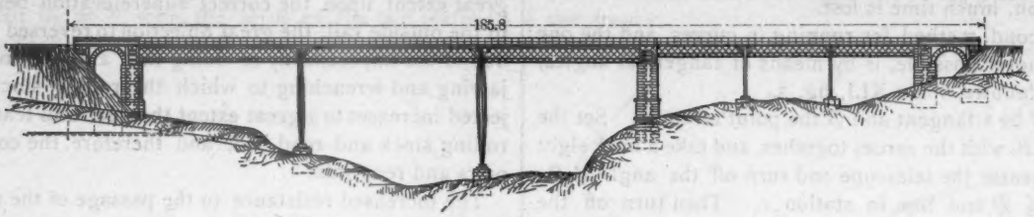
The viaduct across the principal valley is formed by a continuous girder of 333 ft. in length, forming three spans of 106.5, 120, and 106.5 ft. in length; the smaller or secondary valley is spanned by a shorter continuous girder of only 177 ft., divided into three spans of 59 ft. each in length. At the two ends of the viaduct are abutments of masonry, and an intermediate pier, also of masonry, serves as an abutment common to both continuous girders. The short intermediate piers are formed by oscillating pillars or towers of iron, and these oscillating pillars are the peculiarity of the work. Owing to the joints on which these piers move, they can follow the longitudinal movement of the girders, caused by the passage of trains or by contraction and expansion.

The accompanying sketch shows in fig. 1 a general view of the bridge on a small scale; and in fig. 2, on a larger scale, the construction of one of the oscillating piers. The dimensions on these cuts are in meters and millimeters.

Similar oscillating piers have already been used in the construction of the viaducts at Lysedalen, Solbergdalen, and Haabolbach in Norway, but the arrangement of the joints and the details of construction of the piers in those

works were different from those of the bridge which is now described.

The abutment common to the two girders is 52½ ft. high above the ground, and has a transverse section of about

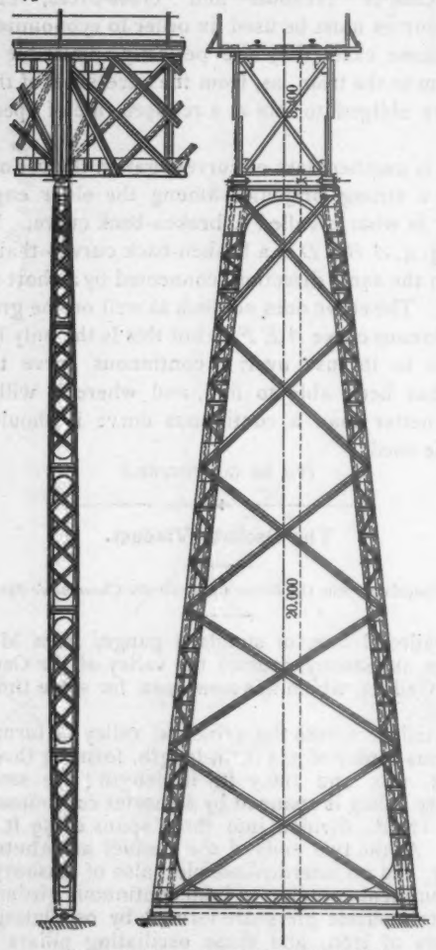


THE OSCHUTZ VIADUCT.

(*Dimensions in Meters.*)

248 sq. ft. The abutments at the ends of the viaduct are each formed of sandstone arches. The sockets of the lower joints of the iron piers are of granite, and in their foundations are openings, which permit of an easy inspection of the condition of the joints.

The track is of steel rails placed on longitudinal sleepers of rolled iron. The sleepers and the rails are of the same length, 24½ ft. On the abutment common to the two



PIER FOR THE OSCHUTZ VIADUCT.

(*Dimensions in Meters.*)

girders of the viaduct there is an apparatus of the Klette system, to permit the expansion and contraction of the girders.

The large girder is 9.8 ft. in height between the axes of its horizontal members; for the short girder the corresponding height is 4.9 ft. The large girder weighs about 333,000 lbs., or about 1,000 lbs. to a running foot; the weight of the smaller one is 141,000 lbs., or about 800 lbs. to the running foot.

One of the two intermediate piers supporting the large girder is 52½ ft. and the other 65½ ft. in height; those of the smaller girders are both 26 ft. in height. The profile of these piers is that of columns swelled out in the middle. Each is composed of two similar columns, which are joined together by counterbracing, in order to give them sufficient resistance to the action of the wind, the greatest possible pressure of which is assumed at 31 lbs. to the square foot. The inclination of the members of the large columns is 1 in 9; of the small columns 1 in 6. The large columns have rectangular sections and the small ones cylindrical. The form of the columns enlarged in the middle was adopted for the reason that the wind pressure increases considerably the longitudinal compression; and also because experience in America and England has shown that the longitudinal compression of long columns is not to be feared when the mean diameter of the column is not less than $\frac{1}{30}$ of its height. The transverse elevation of the piers in fig. 2 shows that the counter-bracing is sufficient to give the desired security against compression.

In building the bridge, the small viaduct was first erected and then the larger one. The iron pier of 65½ ft. in length was erected in three pieces, that of 52½ ft. in two pieces, and the short ones in a single piece. Wooden scaffolding supported the piers during the erection. The total weight of iron entering into the construction of the viaduct is 255 tons. The work on the bridge occupied in all 8 months, the actual erection taking 13 weeks.

The cost of the bridge was $50,400—that is, as the engineers calculated, about $1.50 per square foot of the profile of the valley.

THE FIRST DESIGN FOR A BRIDGE OVER THE HUDSON.

ONE of the earliest works on bridge construction published in this country—in fact, the first of which we have any knowledge, was a "Treatise on Bridge Architecture," published in New York, in 1811, by Thomas Pope, who describes himself as "architect and landscape gardener." A copy of this book, which is now very rare, has come into our hands through the courtesy of a subscriber. Mr. Pope might also have added "poet" to his titles, for he not only has a habit, somewhat startling in a scientific work, of dropping into poetry upon any occasion, but he concludes his book with a poem some eight or ten pages long, in heroic measure, intended to impress upon the readers the merits of his favorite design. About one half of his book is devoted to a history of bridges, containing descriptions of many of the noted bridges, both ancient and modern, which had been built up to his time, in all parts of the world, Europe and Asia as well as in America. This part of the work is profusely illustrated, and the Author evidently had more artistic than poetic taste, for the engravings are of remarkable excellence for that period, when the art was in a very much lower state of development than it has since reached.

In addition to this history of bridges, we have some general remarks on the Nature and Strength of Timber, the best methods of cutting and using it, etc., which tend to show that he had a considerable practical knowledge of

this subject. The remainder of the book is devoted to a description of the "Flying Pendant Lever Bridge," invented and patented by the Author, and on this part he has evidently expended the greatest amount of labor.

In this pattern of bridge he evidently felt the fullest confidence, for in his treatise, in addition to the description and general plan, he gives estimates and designs for bridges from 200 up to 2,400 ft. span. In this connection he presents a design for a bridge across the Hudson River, which is undoubtedly the first definite design ever presented for spanning that stream; and although it differs widely from the Poughkeepsie Bridge and from other later proposed structures over that river, it has seemed to us of sufficient interest to our readers to reproduce the engraving of the proposed bridge which its designer has left us, and also some notes as to his description.

It will be seen from the engraving that Mr. Pope proposed to span the river with a single arch of timber resting on heavy abutments. Upon the construction and solidity of these abutments he laid great stress; but he did not intend that they should be merely masses of masonry, useless for any other purpose than a support to the bridge. By a system of arches and buttresses he proposed to construct them in such manner that they would serve the purpose of abutments and could also be used as warehouses, thus anticipating by some 60 years the plan actually adopted for turning to advantage the vacant spaces under the arches of the Brooklyn Bridge.

The bridge itself, as indicated by the engraving, was to be of timber, securely framed and dovetailed together, forming two flat arches upon which a roadway was to rest. The arrangement of the timbers in these arches, he claimed, was such as to secure at once strength and lightness; while the timbers were so placed that as each was put in position, it served not only to lock back and secure those already in the arch, but also to furnish a new fulcrum or support for the additional timbers.

Mr. Pope sets forth the excellences of his design by an elaborate argument arranged in propositions and scholia, in the somewhat pedantic fashion of the day. His argument as a whole is too long to be here reproduced; but some of the advantages which he claimed are: That his bridge is founded upon clear and distinct geometrical principles; that the required strength could by his plan be obtained with a less expenditure of material than in any other way; that very little bracing would be needed to resist the wind pressure, as the frame of the bridge itself constitutes almost sufficient bracing; and lastly, that an arch of this kind could be built out from the two ends without false-work or framing of any kind, as when the ends were once firmly secured in the abutments the framed timbers could be added piece by piece, until the two ends of the arch should meet in the center. He also claimed that at any time when necessary for repairs, or for any other purpose, a section of the bridge 40, 50 or more feet in length might be taken out in the center in a very short time and replaced almost as quickly. The timbers required could all be cut of proper size, framed and prepared before putting in place, so that the actual erection of such a bridge could be very quickly done.

VIEW OF T. POPE'S FLYING LEVER BRIDGE.

Let the Broad Arch the spacious Hudson strides
And span Columbias Rivers much more wide.

Convince the World America begins,
To foster Arts the ancient work of Kings.

The roadway could be carried either on top of the structure or between the ribs; and in the latter position the bridge could be roofed over, thus fully preserving it from the weather. Many other advantages are named, but these comprise the principal ones.

We are not aware that Mr. Pope's arguments, however, were successful in convincing the capitalists of his day, and, so far as we know, no bridge on the "Flying Pendant Lever" plan was ever actually constructed, even on a small scale. If so, it was not any fault of the Author, who evidently had the utmost confidence in himself and his plan, and would doubtless have been willing to prove its excellence not only by scientific syllogisms, but by actual practice, if the opportunity were afforded him.

Mr. Pope seems to have had an excellent opinion of himself, for in the commencement of his account of the

method for constructing the bridge he says: "The mode of constructing a bridge on this important invention is perhaps the most singular and also the most simple thing that has ever entered the mind of man." As a further example of his confidence in his own powers, we quote the summing up of his argument as follows:

EXTENT.—From a recollection of the many absurd opinions lavished on this invention, at its first promulgation, by characters the least to be expected, namely, of those who profess a vast knowledge in science, the author has been ready to conclude that he would suspend for the present any information on this important part of the subject; preferring rather to wait the period when ocular demonstration should sufficiently punish the gross ignorance of these pretenders to science and enemies to the useful arts.

But the Author has also considered that if a Bridge on this plan be indeed capable of the vast extent he has heretofore asserted, and which, from a multiplied conviction of the excellence of its principles, he still dares to assert; how dishonorable would it be on his part, were he to shrink from the just vindication of its true merits because a mere quack philosopher and two or three bookful theorists (who may be looked up to by some as *Gods in Science*, but who are in reality of those that are the pests of the arts in every age)—because these, in the plentitude of their wisdom, may think fit to doubt the existence of the vast powers vested in this invention, without having once investigated even one of its golden properties.

The narrow limits that persons of this description have been disposed to fix for the utmost extent of a Bridge on this plan have at once evinced to the candid and intelligent part of the public, who have chosen to judge for themselves, that these sage persons were certainly under the influence of one of two things; namely, a total ignorance of the invention, or a contemptible opposition to its success.

But, as the sons of science in all ages have ever had such characters to contend with, the Author conceives it a waste of time, at the present, further to notice such pusillanimous conduct. He therefore shall pass on to explain to the undissembled friends of science the grand reasons why a Bridge on this superior plan can be erected to a far greater distance with a single arc than any heretofore invented.

As a specimen of Mr. Pope's poetic powers, and also, perhaps, to show our modern writers on engineering how their works might be enlivened, we give below several extracts from the poem with which the book closes. The first four lines of the poem will be found repeated beneath the engraving.

The arms of Bridge are built of stone or wood,
But iron, cast, would furnish twice the good;
Its extra beauty and its lesser weight
Confound the pride and ignorance of the great.
Combining levers stretch from shore to shore,
And span the foaming flood ne'er span'd before;
By logs of timber plac'd at angles right
The bold formation is made strong and tight;
Each semi-arc is built from off the top,
Without the help of scaffold, pier, or prop;
By skids and cranes each part is lower'd down,
And on the timber's end-grain rests so sound,
That all the force of weight can ne'er divide
Each tabled timber from its partner's side:
And, lest the end-grain should not stand the test,
A sheet of iron's plac'd between each rest,
That no compression or indention can
Make an impression to defeat the plan.
* * * * * * *
If shores supply with rock to build upon,
The builder then hath an advantage won,
By which he saves the cost that oft ensues
In sinking coffers, caissons, or mud-pews.
But should some softer strata heave in sight,
The consequences will be truly light,
As nothing is more easy to provide
Than concave circle on the under side,
By which the pressure will combine to force
The neighboring infirm strata much more close;
Its watery particles must soon escape,
And force the solid grains into a heap,
By which the massy butment rests secure,
And through its firm foundation must endure.
* * * * * * *
When Time, with hungry teeth, has wrought decay,
Then what will sceptics be disposed to say?
Why, "Down the Bridge must fall, without repair,"
And all the Author's pleadings will be air."
Not so, he's better arm'd than you expect,
For nought can bring to ruin but neglect;
A mean's provided, which can never fail,
To keep up strength whate'er the Bridge may ail:
Each log of wood, where'er its station be,
Is safely shifted for a sounder tree,
With greater ease remov'd than heretofore
A piece could be repair'd in an old floor.
* * * * * * *
The Author's Bridge shall surely rise to fame,
In spite of envy's efforts, power, or claim,
And men of liberal science own its worth,
Respect his name and cultivate its growth.

In justice to Mr. Pope it must be said that the prose of his book is better than the poetry, and he was evidently, if not an eminent engineer, at least a student and a careful compiler.

NOTES ON THE SEWERAGE OF CITIES.

(Translated from paper of M. Daniel E. Mayer, Engineer, in the *Annales des Ponts et Chaussées.*)

I.—NEW IMPORTANCE OF THE QUESTION OF SEWERS.

FORMERLY but few sewers were built, and those were only intended to carry off the rain-water which fell in the streets.

To-day, however, new demands have arisen in the hygienic administration of cities.

That pure drinking water is a primary necessity of health has been fully demonstrated. Hence, every collection of people deriving its supply of water from wells fed by a subterranean stream or basin, implies the necessity of preventing the pollution of this basin by the infiltration of foul water, whether the result of the ordinary processes of life or the refuse of manufactures.

Hence, the idea of providing channels to carry off this polluted water.

It is true that the system of supplying houses with water from small wells is inconvenient and insufficient, and that the tendency of every collection of people in a town or city is to provide for a public supply of water.

This step of progress, however, the most useful of all to the public health, does not do away with the necessity of providing channels of escape for the foul water, which would otherwise either soak into the ground or pour into the gutters of the streets.

It can even be said that, from a certain point of view, the public distribution of water and the suppression of wells render even more pressing the necessity of sewers. In fact, the subterranean streams or basins, whose level was before kept down and regulated by the wells, tend toward a higher and a variable level. In their rise they impregnate the organic matter contained in the soil of cities; and when they fall this detritus, left to dry, ferments. The results are so serious that in several countries a relation has been observed between the rise and fall of these subterranean waters and the prevalence of epidemic diseases.

Notably in Munich and Vienna we have seen the municipal administrations occupied with this question. Now sewers preserve the soil from pollution by these germs of infection, and sometimes are used to lower and regulate the subterranean streams.

Another matter is involved in the introduction of city sewers; it is one still much in controversy, but in our eyes one of the most important. If we wish to suppress, even in the poorest houses, those privies which render the

dwellings to which they are attached both disagreeable and unhealthy, and to replace them by water-closets which can be abundantly flushed,* it is necessary that the disposal of the waste water shall not cost, as it will by the system of cesspools, 10 or 20 times as much as the introduction of pure water. This waste water can be disposed of economically only by sewers. One can hardly count the cities in England and Germany where this system works without inconvenience; this is why, without intending disrespect to those eminent men in France who are opposed to it, we do not doubt that it will finally prevail; as well as the process of purification of polluted water by the soil, of which Paris has shown one of the earliest and best examples, and which Berlin has applied with success.

The sewer problem, then, has taken a new and more general character. It is no longer a question of building an isolated channel to drain a spot of low ground or to keep some main street dry. It will be necessary to make general plans, and to lay out a system of sewers as complete as the system of streets. To the self-interest of the cities will be joined the outside pressure from the Government, which desires to prevent the pollution of the rivers.

As a rule, these questions belong to the municipal administrations, which do not devolve upon engineers. But, even outside of the large cities, like Paris, where the public works are under the charge of the engineers of the *Corps des Ponts et Chaussées*, those engineers will have to interfere in the question of sewers, either in connection with their duties in charge of the roads, or as consulting engineers of the Government. It will not be useless, therefore, if in this matter, still comparatively new here, we consider and lay down certain rules, based on the nature of the subject itself and on the experience of other countries.

II.—FUNCTIONS OF A CITY SEWER.

In Paris the subterranean galleries which go under the name of sewers serve many uses. They contain the water-pipes, of which there are two in each street, their diameter being sometimes as great as 1.10 meters. There are placed in them also pneumatic tubes, the telegraph wires, the electric cables, etc., etc., which are thus made accessible at all times without disturbing the public roadways. In Paris, where the streets are comparatively narrow and there is an enormous traffic, this advantage is very valuable. It is for this reason that this subterranean system, the first conception of which is due to the great engineer Belgrand, is of incontestable utility in that city; and the systems for distributing heat, light, and power are now disputing for possession of the little space which still remains to be disposed of.

But such a system of sewers, admirably adapted to Paris, would be inadmissible in an ordinary city. Of the large cities in England and Germany, which have recently been provided with a system of sewers, there is not one where the idea has been advocated of following the great but necessarily unique example of Paris. This example also would be fatal in the smaller French cities, if they should make the mistake of attempting to follow it.

The reason is that while the surprising accessibility of the types of sewers used in Paris is excellent, the attempt to construct in small cities passages high enough to permit the passage of a man would lead to results too costly for their finances.

It is also probable that, in designing a system of public works for a large city, it would be better to provide tunnels apart from the sewers for the water-pipes, steam-pipes, wires, etc.

The amount per inhabitant which can be drawn upon yearly is usually much less in the provincial cities than in Paris. In Paris the yearly budget of the city is over 100 francs per inhabitant; but this is three times as much as in most of the provincial cities. The figures continually tend to become smaller as the collection of people is smaller and less important. On the other hand, what may be called the urban density—that is, the population per unit of surface—is much greater in Paris, so that a kilometer of sewer in a small city serves a much smaller number of inhabitants than in Paris. Unless we make the important fraction of the yearly expenditure which Paris devotes to the sewers five to ten times as great in a smaller city, which would have disastrous results, it is necessary that a kilometer of sewer should cost five to ten times less in those cities than in Paris.

This result cannot be attained by admitting Parisian types with the dimension reduced by a few centimeters; there must be a radical change of the system.

It must be admitted, in the first place, that sewers, as their name would show, have for their essential function the discharge of waste waters; and that the size of these works should be rigorously adapted to the duty which they must perform. This principle will permit us to make in smaller towns channels very much less costly than those in Paris.

It may be said, the application of this principle will compel us to make, in less important towns, very small sewers inaccessible to workmen.

In order that these should not be obstructed, it will be necessary to give up the Parisian habit of considering the sewers convenient receptacles for everything, for which there is no place on the surface, such as garbage, refuse of factories and slaughter-houses, street sweepings, sand, etc., etc. Without doubt it is very convenient to clean out a house or the street by throwing everything into the sewer; but this convenience must be paid for by an enormous increase of expense, both in the first construction of the sewers and in keeping them clean.

The sewer should receive all the waste water, but nothing but the water. This is a rule easy to lay down but not so easy to enforce; what rules and what police will be necessary for the purpose?

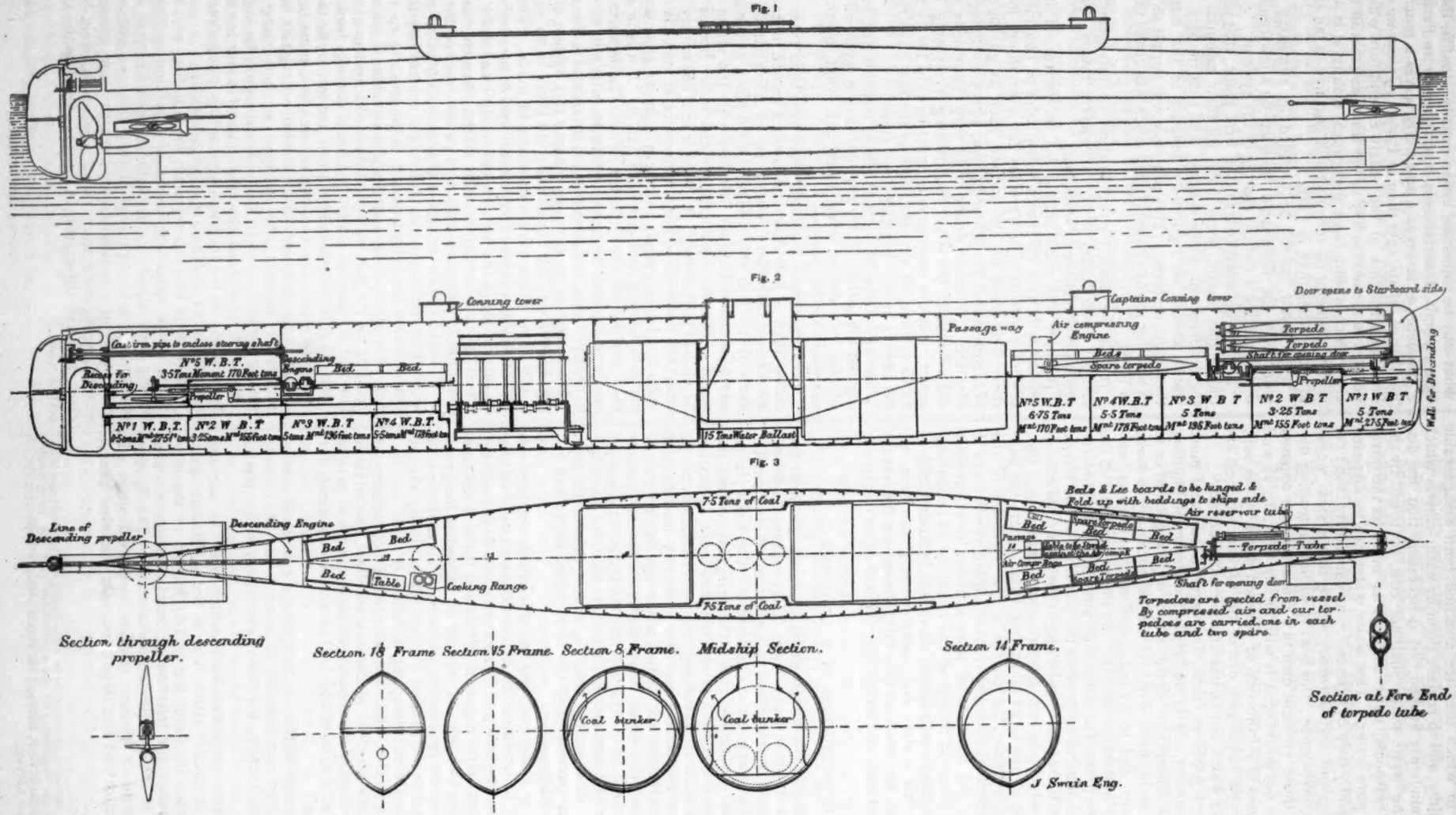
There is happily a method more sure than rules and less costly than a policeman; it is not a recent invention, for we believe that Hero, who lived in Alexandria 150 B.C., knew of it. It is the siphon. If we place at the points of communication between the house or the street and the sewer a reversed siphon, heavy and bulky bodies will not be able to pass through it. If it is in a house they will obstruct the connection, the maintenance of which is charged upon the house-owner, and he will be at once warned of his carelessness and punished for it. If it is in a street, such bodies will be retained or will be deposited in the connections, and the street cleaners, who will be obliged to remove them, will soon learn to be careful in this respect.

We forbid in an absolute manner this system of throwing everything into the sewer; but there is an exception to this rule, which must necessarily be made. There is a certain class of refuse (excrementitious matter) which can be carried off in the sewers, on condition that the closets are supplied abundantly with water, because when this condition is complied with, this refuse reaches the sewer in a liquid condition and sufficiently diluted to pass off without interruption. In view of the controversy to which this question has given rise, it is interesting to observe that, after all, it is not necessary to consider it seriously in deciding on the plan and conditions of a system of sewers. The fact is, that the amount of water coming from water-closets is relatively smaller in comparison to the total discharge by which the capacity of the work must be fixed; and, as to the measures taken to secure a regular flow and to prevent deposits, the existence of foul water which usually becomes a source of disease would be sufficient, either with or without the admission of water for flushing the sewers, to render such precaution altogether indispensable, even where no water-closets exist.

An eminent English engineer, Mr. Lindley, who has designed some important works of this kind in Germany, having been asked by the authorities of Eberfeld to present two plans for sewerage of that city, one with and the other without the admission of water from closets, answered, with good reason, that a single plan would be sufficient, because the system of sewers would be the same in either case.

(TO BE CONTINUED.)

* It is hardly necessary to note that in this country there is no longer any controversy as to the superiority of the water-closet over the privy-vault from a hygienic point of view, although M. Mayer seems to imply that there still is in France.—EDITOR.



THE NORDENFELT SUBMARINE TORPEDO BOAT.

The Nordenfelt Submarine Torpedo Boat.

(From the London *Engineer*.)

THE accompanying illustrations show the Nordenfelt submarine boat, "No. 4," which was tried in the presence of Government officials and foreign attachés at Southampton on December 19 last. The form is entirely changed from the cigar or double conical shape of the preceding patterns. The cross-section midships is now an exact circle, which closes as it moves toward bows and stern, passing through a double ogival or Gothic arch, which narrows more and more until it ends in a vertical line forming each actual end of the boat. This form does not cause the boat to be subject to the same eccentric and dangerous effects as were produced with the cigar shape, notably in suddenly stopping, as has been found necessary for fear of fouling some vessel, as occurred in the trial in the Bosphorus. The cupolas or "conning towers" shown furnish the means of entrance into the hull of the boat, and remain available for this purpose until the boat is submerged to the level of the surface of the superstructure, as shown in the highest long horizontal line in figs. 1 and 2.

The captain and part of the crew occupy the stern end of the boat, and the engineers the forward part; the engines are amidships. The captain can communicate with the men forward by speaking tubes, and has the working of the boat in complete control, having at his hand the gear for all movement, and for revolution or stoppage of propellers, shown in fig. 1, and for the horizontal screws shown in fig. 2, which cause the boat to descend or rise. The crew, in fact, have no means of knowing whether the boat is on the surface or below, when once the cupolas are closed, with the exception of the men who enter their heads into the glass domes at the apices of the two cupolas or conning towers. Generally, the captain occupies the stern dome, and one of the engineers the forward one, while the boat is being adjusted to any desired position. The two portions of the crew are not cut off from each other, as there is a passage over the boilers through which a man can creep. For submarine action, the chimneys are removed amidships, and covers are closed over the openings, the glass domes are tightened over the manholes in the cupolas, and the crew then are dependent on the stores of air and steam that are contained or provided for in the boat, whether on the surface or below water. This state of things has been maintained for eight hours at a time, although the boat is generally wholly submerged for only a short part of that time. The boat is adjusted for submarine action to float with the superstructure level with the surface of the water. The horizontal screws then by their revolution keep the boat beneath the surface; and if the engines stop from any cause, the boat rises to a position in which the crew could escape through the manholes of the cupolas. Torpedoes are discharged from the bows of the boat a little above the horizontal screw. Three torpedoes are shown in fig. 2 at the bows. Mr. Nordenfelt proposes to make much heavier torpedoes than those of the present Whitehead pattern. Thus in attacking a ship, the *Nordenfelt* would have two advantages over an ordinary torpedo boat. She might expect to approach much closer before discharging her torpedoes, and thus she might hope to send two torpedoes in succession on to the same spot. This, in the case of having to effect a passage through protecting netting, would be a great advantage, as the first torpedo would open a way which would only be available for another following exactly in the same path. Then the increased weight and momentum of Nordenfelt's torpedo, although its speed would be less, would carry it through obstacles better than the lighter pattern.

Nordenfelt has made the boat strong enough to resist the pressure of water to 60 ft. depth. This appears to be sufficient for all practical purposes, especially as the boat might generally be used in defending passages where the depth is not considerable. It must be apparent, however, that the physical conditions under which the boat works are novel in many respects, and call for special nerve, skill, and experience, especially in the captain, in whose hands the boat is placed in so exceptional a way.

THE ZALINSKI PNEUMATIC TORPEDO GUN.

AT the December meeting of the United States Naval Institute in Annapolis, Captain E. L. Zalinski, U.S.A., read a very interesting paper on the "Naval Uses of the Pneumatic Torpedo Gun." We give below some extracts from this paper, for which, and for the accompanying illustrations, we are indebted to the courtesy of the Institute.

THE GUN.

The gun-barrel consists of a very light tube having, at present, a smooth bore. As the firing pressure used does not exceed 1,000 lbs. per square inch, it will be seen that, if made of steel or aluminum bronze, it need not be more than ½ in. thick even in calibers as great as 20 in.; a greater thickness has been used in the 8-in. and 15-in. guns, for the purpose of obtaining somewhat greater rigidity and to lessen the chances of mechanical injury in transportation and manipulation. Where it is important to eliminate weight, as on shipboard or on torpedo boats, these tubes can be made very light indeed, especially in cases where they are placed at a fixed angle.

When the machine is to be movable for elevation or direction, or both, the barrel is supported on a suitable truss.

The breech mechanism is ordinarily a simple gate arranged so that the valve mechanism cannot function until the breech is closed and latched.

THE VALVE.

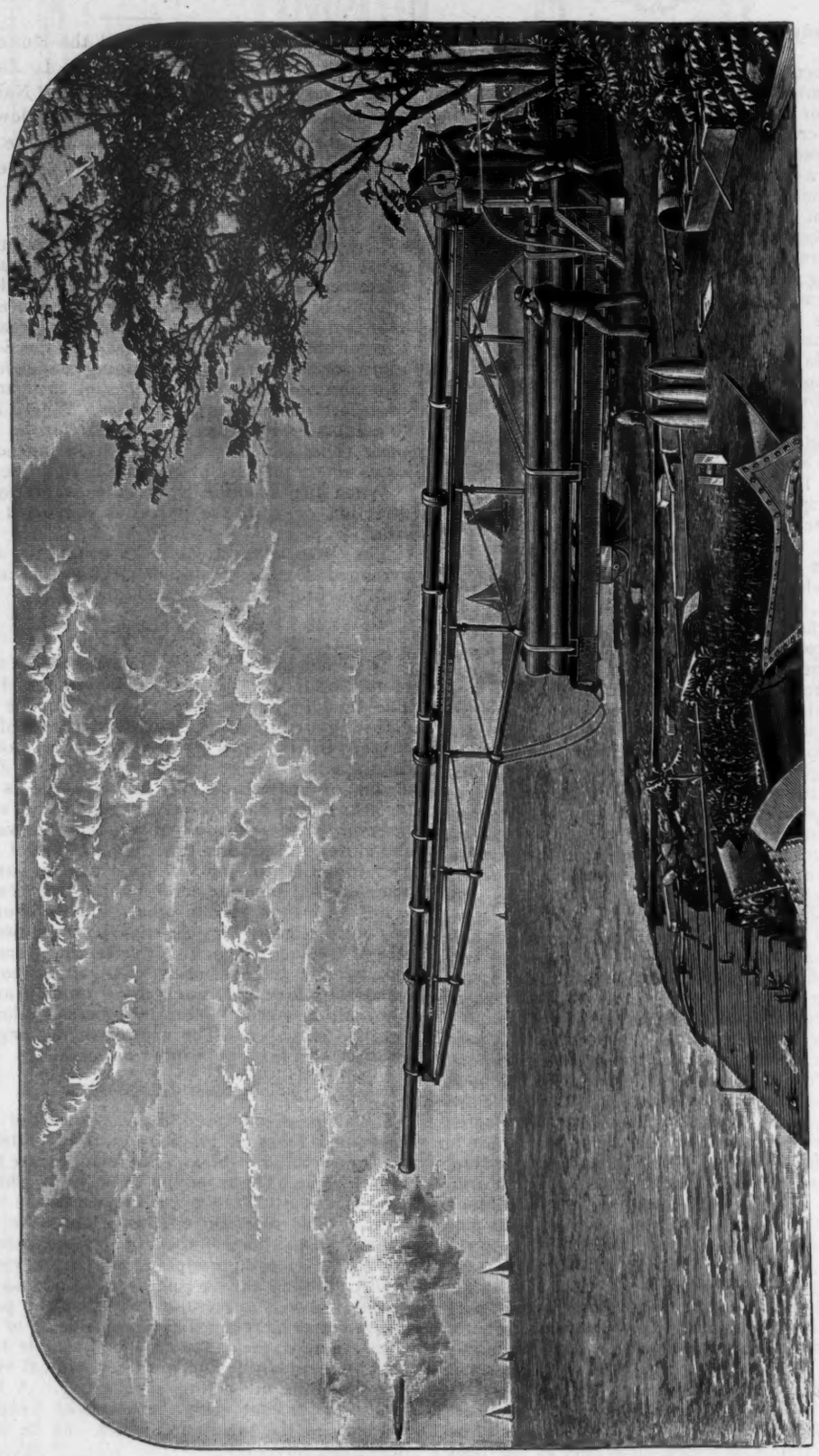
The valve is known as a balanced valve, so arranged as to open and close by a single movement of the operator. The time of opening and closing can be varied by an adjusting device so that any desired loss of pressure will ensue. In this way the range can be changed without change either of elevation or pressure. In addition to this means of controlling the range, there is a device for throttling the passage-way between the valve and the reservoir of the gun, so that although the valve may open and close in a uniform time, the amount of air which can pass into the gun in that time can be varied. A more complete and accurate control of the range can be obtained in this way than in any other. The size of the passage-way can be quickly regulated to a hair's breadth. In the case of a vessel advancing or retreating from a target, the opening can be constantly changed to conform to the variations of range, much more quickly and accurately than can be accomplished by corresponding changes of elevation of a gun. The accompanying engraving represents the 8-in. gun in position on land.

THE RESERVOIRS.

The air reservoirs used thus far consist of wrought-iron lap-welded tubes of 12¾ in. and 16 in. outside diameter, and from ½ to ⅝ in. thick. These tubes are from 18 to 20 ft. in length. The reservoir tubes from which the air for firing is directly drawn are known as the "firing reservoirs." This reservoir will, as a rule, have five times the capacity of the bore of the gun. Experiments are under way with a view of producing very light reservoirs, both by wire-winding and by cold drawing of brass and steel.

It may be well to mention here that the pressure in the reservoir may be reduced by a single firing to any predetermined amount, the valve being adjustable to accomplish this automatically. The most economical results are obtained with the air acting expansively. A loss of 10 per cent. to 12 per cent. with a reservoir of 5 capacities of the gun bore is the maximum which can be used with any appreciable advantage.

Where it is desired to fire a large number of rounds with great rapidity, an auxiliary storage reservoir is used, into which the air is compressed ordinarily to twice the pressure to be used in the gun. After each discharge the



EIGHT-INCH PNEUMATIC TORPEDO GUN.

air is drawn from these, to restore the pressure in the firing reservoir to any desired point.

THE COMPRESSORS.

The air compressors may be of any type capable of giving the high pressures to be used. We have used the compressors of the Norwalk Iron Company. These compressors perform the compression in two stages, there being an intermediate cooling in passing from the first compression to the last.

Where cooling processes are to be used for other purposes on shipboard, the air compressors can be utilized. They may also be of use where the pneumatic gun-carriage system is introduced.

THE SHELL.

The shell is made at present of brass tubing and castings, made as light as consistent with the necessary strength for handling and in being fired. The shell is retained in its proper trajectory by means of the tail tube, to which are attached spiral vanes. It is centered in its passage through the bore and kept from metallic contact with the same by means of non-metallic pins in the head, the leather gas check at the rear end of the cylindrical part of the body, and by the vulcanized fiber projections riveted to the spiral vanes of the tail.

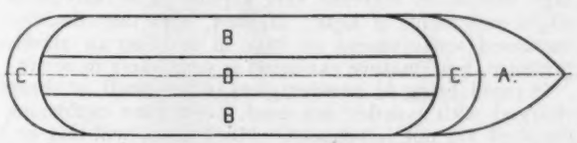
We have recently succeeded in making the conical point and cylindrical portion of the shell of a single seamless piece, it being produced by hydraulic pressure. This was not considered easy of accomplishment in view of the fact that, for the 15-in. shell, the piece is 14¾ in. outside diameter, 80 in. in length, and ½ in. thick. The conical point is made strong enough to resist crushing from impact with water, but so thin as to readily crush when striking a solid target.

THE CHARGE.

The charge used thus far has been uncamphorated explosive gelatine, having a core of dynamite. This core is for the purpose of producing a complete detonation of the less sensitive explosive gelatine. I would prefer, for this purpose, compressed dry gun-cotton, as cold weather does not affect its properties as a detonating substance. The arrangement of the charge is essentially as shown in the diagram.

At the front and rear of the charge, I would use camphorated gelatine to increase the chances against explosion by shock both in starting the shell and in striking the target. For this purpose also a diaphragm is placed so as to stop off the charge some distance from the point; this will give time for detonation of the charge from the *rear end* before the front can be exploded by shock. To guard still further against the possibility of explosion by the impact and give time for the electrical primer to act, it may be necessary to place a cushion of felt or other elastic substance in front of the diaphragm. This can only be determined by actual experiment against armor plates.

The small engraving herewith shows the arrangement of the charge; *A* is the empty space at point; *B B* uncamphorated gelatine; *C C* camphorated gelatine, and *D* the gun-cotton or dynamite core.



ARRANGEMENT OF CHARGE FOR DYNAMITE GUN.

I have preferred uncamphorated explosive gelatine because it gives the maximum explosive energy for specified volume of shell, both on account of its very great energy and its high specific gravity. The energy compared to dynamite No. 1 is as 142 is to 100, according to General Abbot and other authorities. Its specific gravity is 1.6 compared to 1.2 of dynamite No. 1 and 1.0 of gun-cotton. Thus, in a given volume of shell the explosive energy, where uncamphorated explosive gelatine is used, will be as 189 is to 100 when compared with the same volume of dynamite; compared with dry gun-cotton, it would be 263 to 100, or close on to 2¾ times the explosive energy. If *wet* gun-cotton is to be used there is a strong probability of the relative strength being greater. I am aware that there is some question as to the relative strength of gun-cotton as given by General Abbot, but it is seen that a large margin is likely to remain in favor of the explosive gelatine.

It will undoubtedly rest with each branch of the service to select that explosive which seems to it safest and best. I merely mention my own reasons for having selected and used uncamphorated explosive gelatine. I have used this for more than two years, during which time I have fired more than one ton of gelatine made at the Nobel's Explosives Company's works near Glasgow. Besides use in the gun I have subjected it to various tests of alternations of heat and cold, as well as subjecting it to very severe shocks. I am satisfied from this experience that, if well made, it is not subject to deterioration while in store, or to explosion by shock if handled as carefully as gunpowder.

The only unfavorable thing that I have observed, and that but rarely, is a very minute exudation of nitro-glycerine when thawed after freezing. I propose to meet this contingency by having the cartridges made up in disks having a central hole for the detonating disk of gun-cotton. These large disks are to be covered completely by a rather thick covering of asbestos paper or other absorbent material, having incorporated therewith an alkaline substance, such as carbonate of magnesia, so that any exudations of nitro-glycerine will be absorbed by the covering, and any free acid which might be present or develop in the exuded nitro-glycerine will be neutralized. Besides this, the thick non-conducting envelope will partly protect the explosive from great alternations of heat and cold.

In view of the advantages of the explosive gelatine and the improvements made in its manufacture, it will be well to make thorough tests therewith before definitely settling upon the exclusive use of gun-cotton. While reliable explosive gelatine has thus far only been procurable from abroad, at least two of our reputable and experienced manufacturers of high explosives are prepared to manufacture the gelatine under the Nobel patents and processes.

THE FUSE.

The earliest experiments with the pneumatic gun demonstrated that the ordinary fuse arrangements were insufficient to obtain the best results with high explosives.

It was found necessary to produce the initial explosion at the *rear* end of the charge, to produce the maximum effect on a solid target.* It was important, therefore, that this explosion should take place an instant *before* full impact.

To obtain the very important torpedo effect which is the primary object of the pneumatic torpedo shell, it was necessary to cause the explosion to take place an interval of time *after* striking the water. The tamping due to the submersion would give the maximum energy of the charge, and this against the more vulnerable under-water hull. Where counter-mining was to be attempted against ground mines, it was desirable to ensure some of the shells getting to or near the bottom before exploding. Above all, the fuse must be assuredly safe in storage and in handling. Consideration of these requirements has led to the development of the electrical fuse.

This consists of four parts:

1. The electrical battery;
2. The low-tension primer;
3. The circuit breaker; and
4. The detonating cap.

The chloride of silver battery has been selected as being most suitable. Although the electro-motive force is low, the internal resistance of the battery, as made, is very low, and a small single element suffices to bring the bridge to a red heat. But to ensure against accidental increase of

* I fired a shell charged with sand only against a target of thin iron plates, and three were perforated. A shell charged with dynamite arranged so as to explode by impact from the front end was next fired, and only one plate was perforated. A shell charged as before, but arranged so as to explode from the rear end, was fired and six plates were perforated, that being all that constituted the target. Commander Folger's experiment also indicated the necessity of having the initial explosion at the rear end of the charge.

resistance in the circuits and to reduce the *time* required to fire the primer, one set of batteries is made quadruple, the other two are double.

Each set is arranged in series. All of the elements of the quadruple battery, which is in the rear end of the shell, are wet with salt water before insertion into the shell. One pole of this battery is connected, through the primer embedded in the fulminate of mercury detonator, to the metallic body of the shell; the other pole is connected with a light copper cone fixed in the conical point of the shell and insulated therefrom. The shell striking any solid target, either normally or otherwise, will cause the outer shell to crush in on the insulated cone, close the wet battery circuit and explode the charge.

The double dry battery is placed in the point and another at the rear end. This last is inserted as a matter of precaution rather than as an absolute necessity. One element of each of these double dry batteries is wet up, and is ready for action as soon as the salt water enters the other element. Upon the shell entering the water, the dry element becomes wet, the current then passes through a primer which ignites a time train. This in turn ignites the detonator. The time train is adjustable so that a variable submersion before explosion can be obtained. The rear dry battery acts in the same manner should the other fail. If it is desired to cause the shell to reach the bottom before exploding, a water cap is attached to the dry battery in the point of the shell. Provisions are made to protect the front and rear batteries from moisture until the shell has left the bore of the gun. If fighting in fresh water, a small bag of salt is placed in the dry battery fuse case.

The circuit-breaking device ensures all circuits being retained open until the shell has left the bore of the gun. If anything should be amiss with the circuits, no explosion will result until the shell is some distance beyond the muzzle. Nothing can be amiss, however, if proper care is taken in making up the shell, arranging the circuits, and testing. The circuits can be tested at any time before inserting either the batteries, primers, or detonators; there need be no guess-work as to the condition of the circuits at any time. The batteries, primers, and detonators need not be inserted until just before using. A double set of circuit breakers, primers, and detonators are used to increase certainty of action.

To guard against the chances of breaking the very fine filament of platinum wire constituting the wire bridge, it is embedded in a very solid cake of compressed gunpowder. . . . . .

RIFLING.

To the professional mind it naturally occurs that it would be well to resort to rifling, dispensing with the long and cumbersome tail. To rifle a projectile so long and so low in density as the one in use would involve an exceedingly rapid twist. According to Professor Greenhill's formula, a twist of 1 in 13 is required for a cast-iron shell 8 calibers in length. This will be about the average length of the dynamite shell without the tail; it being, however, somewhat shorter in the larger calibers. The density of the charged shell will be much less than that of the common iron shell; hence it is probable that a twist of about 1 in 11 will be required. To impart so sharp a twist will put a very considerable torsional strain on the thin wall of the shell, as also on the (proportionately) equally thin walls of the gun. Again, the explosive will have to sustain an additional shock due to the very high angular velocity imparted to the shell. There is very great danger from the heat which will be generated in the friction of the projectile while being forced through the gun bore.

While, as an artillerist, my natural predilections were for rifling, consideration of the foregoing facts led me to make haste slowly in this direction. I had constantly before me the experience gained at the proving ground at Sandy Hook and in foreign services, where the usual result of the experiments of firing the high explosives from rifled powder guns was a final dissolution of the gun.

Consideration of the matter has led me to see a number of ways by which some of the difficulties I mentioned may possibly be overcome. I have now a 2-in. rifle gun in which I shall test the matter even to the final bursting of the gun, establishing by my experiments, if possible, the limits to which the rifle can be used with safety.

USE OF GUNPOWDER FOR PROPULSION.

The feasibility of using gunpowder for the propulsion of shell charged with high explosives is continually broached. It has been frequently tried, but invariably with final disastrous results where the experiments have been carried up to moderately large charges. By large charges I refer to shell charges of not less than 50 lbs. and reaching up to 1,000 lbs., and even to shell charged with a ton of high explosive.

The advocates, or rather the predictors, of the use of high explosives from powder guns also demand penetration before explosion.

If large charges are to be thrown, the shell must necessarily be made thinner, and it is very doubtful if it will then withstand the concentrated blow it receives upon striking the target so as to penetrate even a moderate thickness of armor. The battering shell of the 100-ton gun contains a bursting charge of only 25 lbs. of gunpowder. It would seem that the walls of the shell would have been made as thin as consistent with ability to perforate armor without breaking up.

Assuming that 25 lbs. of a high explosive could be substituted for the gunpowder, it is very doubtful if it could be carried through heavy armor successfully before explosion. There is no record of large battering shell fully charged with gunpowder having perforated armor over 6 in. in thickness, without explosion until after perforation. On the contrary, explosion takes place prematurely, almost immediately upon impact, with the result of less injury to the target than that produced by an uncharged shell.

Much more surely will this be the case if a high explosive be substituted for the gunpowder as the bursting charge, unless the shell cavity is well cushioned. To do this involves reduction of explosive capacity. The energy available, after breaking up the very thick and tough walls of steel shell, will be but little greater than that produced by the gunpowder. The effect as to material injury or man-killing power will not much exceed that producible by the shell charged with gunpowder.

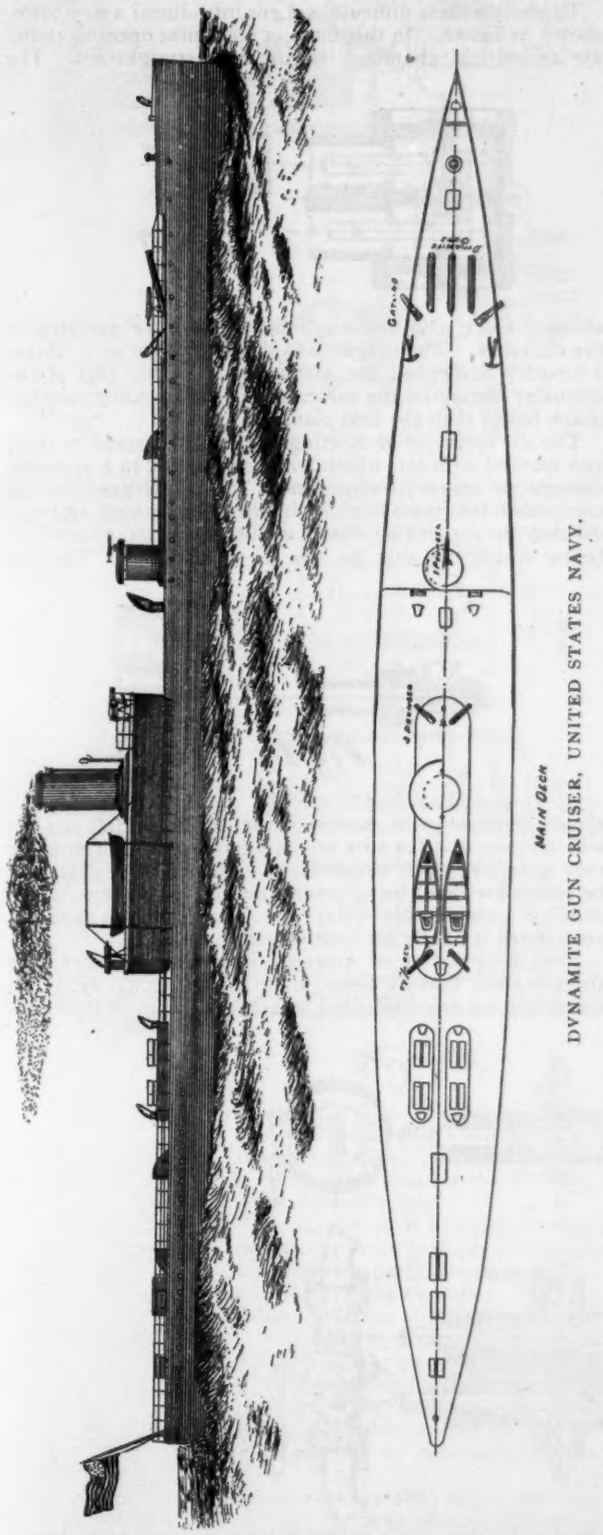
In firing a shell from a powder gun, the walls of the shell must necessarily be sufficiently strong to withstand the initial shock. This limits somewhat the capacity for bursting charge, even where armor piercing is not sought for. If a high explosive is used, some cushioning device is requisite, and a further reduction of capacity ensues.

Assuming that a shell charged with some of the high explosives can be thrown with safety from a powder gun under normal conditions of pressure, it is known that abnormal pressures, varying therefrom as much as from 5,000 to 12,000 lbs. per square inch, are not infrequent. This may be looked for especially when the gun is warmed by continuous firing. In addition to this, the shell and the contained charges may become warmed by remaining in the hot gun bore some little time before being fired. The high explosives increase very rapidly in sensitiveness by slight increments of heat. If, then, with this condition of increased sensitiveness we have in addition an abnormal pressure, a premature explosion is very likely to occur.

In rapid firing of powder guns, when shell or shrapnel charged with powder are used, premature explosions of the shell are not infrequent. Much more will this be the case when the bursting charge is one of the high explosives.

In this connection another matter is to be considered. It is well known that the high explosives are capable of producing more or less violent explosions, depending upon the character of the initial shock or detonation. The more insensitive the explosive, the more powerful must be the detonating charge, to produce an explosion of the first order. Fulminate of mercury appears to be requisite in all cases. But fulminate of mercury is even more sensitive to shock than either ordinary dynamite or dry gun-cotton, hence the resulting shock must be tempered so as not to explode the more sensitive *detonating* charge rather than the specially insensitive *bursting* charge. Wet gun-cotton has been substituted for powder charges, but being quite

wet reduces its explosive ability nearly to a par with gunpowder. Particularly is this the case where no detonating charge of dry gun-cotton and fulminate of mercury is used. Where the explosion takes place by simple impact,



DYNAMITE GUN CRUISER, UNITED STATES NAVY.

not alone is it of a low order, but as the initial point of explosion is from the front, the resulting injury to the target is less than from a blank shell. This was exemplified in some experiments made at the Naval Proving Ground by Commander Folger, U. S. N. . . . . .

THE DYNAMITE GUN CRUISER.

This vessel, now building for the United States, will have three guns of 15-in. caliber. These are placed abreast and parallel at a fixed angle of 16°, the muzzles projecting through the deck at about 37 ft. from the bow. The range of these guns will be at least one mile. The full caliber shell will carry 600 lbs. explosive gelatine, equivalent to 852 lbs. of dynamite No. 1 or to 943 lbs. of gun cotton. Shell containing smaller charges can also be thrown by the system of sub-caliber recently developed. The speed will be at least 20 knots.

The speed of 20 knots is exceeded by the small and very light torpedo boats built abroad, but the hull of this vessel will be sufficiently strong to be serviceable in rough water, which is not the case with the more lightly built torpedo boats. The training of the gun is given by steering the vessel. The range will be varied by the valve arrangement previously referred to.

The vessel has twin screws and steam steering gear. The arrangements will be such that the guns can be fired from the conning tower. The shell are handled by hydraulic machinery throughout the loading, so there is no danger in the manipulation in a sea-way. The guns can be loaded two times per minute ; 30 full caliber shell can be carried.

It will be seen that this vessel is likely to be very well under control and will probably prove itself a formidable auxiliary war vessel.

The general dimensions of this vessel are : Length over all, 252 ft. 4 in.; beam, 26 ft. 5 in.; mean draft, 9 ft.; displacement, 725 tons. The motive power is furnished by two triple-expansion engines, developing about 3,200 I.H.P. The armament, besides the three 15-in. pneumatic torpedo guns, will include two 3-pounder and one 1-pounder rifle, two 37-mm. revolving cannon, and two Gatling guns.

CONCLUSION.

Owing to the unknown character of the pneumatic gun, its possibilities are not generally recognized, and many professional men have been loth to accept it as a practical appliance of war. It is considered by many as a species of quack medicine, as a toy—a pop-gun. I have therefore been constrained to argue the case in laying before you my views as to its applicability to naval uses, basing my arguments chiefly on accomplished facts.

I have pushed this work on as vigorously as I could, because, aside from the professional interest involved, I saw in it possibilities of usefulness in cases of public emergencies which may arise even now, before a regular modern armament could be provided.

While I have never considered it as all-sufficient for defensive purposes, I have thought it a very valuable auxiliary in any event. But most of all, if attacked before modern guns, ships, and forts are provided, we could at least very seriously injure any attacking force before being ourselves destroyed. Our sting will be felt, and an attack will not be made with absolute impunity. The power that we have to inflict *some* injury will not be without weight in considering the advisability of attacking us.

No small element in considering the effectiveness of this weapon will doubtless be the moral effect. The knowledge that escape is not assured when the enemy's missile has failed to make a direct hit, and that the danger may even be *enhanced* by that miss, will not have a reassuring effect on the crew of the vessel attacked.

Absolute infallibility of successful action with each missile from this weapon can no more be assured than with those from the best of modern powder guns under the most favorable circumstances. As I have before said, skill and nerve on the part of the manipulator is as requisite with this as with other war appliances. It is for this that we require highly trained and skillful naval officers. But we have seen that the *probabilities* of attaining desired results are certainly greater than with any other torpedo appliance.

In making an attack of any kind, reliance is not usually put upon the probability of producing successful results with a single shot or torpedo. The chances are increased

by increasing the number of guns used or torpedoes projected. For a given weight to be carried, or for a given amount to be expended (looking at it simply from a commercial point of view), a very much larger number of torpedoes of the pneumatic gun type can be utilized than of any other having any approach to relative effectiveness.

FURNACES FOR BURNING LIQUID FUEL.

(*Continued from page 167.*)

WE continue below the summary of Herr Busley's article on this subject, which was begun in our last number. For the cuts given with these articles we are indebted to the London *Engineer*.

III.—SPRAY FIRES.

This class includes all the later plans for burning liquid fuel. In them the oil is divided into small sprays by a steam and air jet, and is then nearly completely burned up in a vaporous condition by means of the introduction of air. This air is generally introduced by the draft caused by the jet, and the oil is supplied from a tank above; in the case of ships, however, it is pumped up from the hold below. The combustion is so perfect that scarcely any smoke is generated. The temperature attained by these fires is so high that it is usually found necessary to protect the sides of the fire-boxes by fire-brick coverings, or else to divert the direct flame from them. In spray fires the oil is divided into minute sprays by means of sprinklers, and they may be divided, with reference to the construction of these sprinklers, into: 1. Slit Sprinklers. 2. Pipe Sprinklers. 3. Nozzle Sprinklers.

1. The *Slit Sprinkler* which is first on the list, is that of Lenz, shown in fig. 9, which was introduced in 1870 on steamers employed on the Volga and the Caspian Sea. Two pipes lead to the sprinkler in the fire-door. The upper pipe introduces the oil, the lower one the steam. The sprinkler is of cast brass, and divided in two halves by a partition, *A*, so as to prevent the intermixture of the oil and steam. The partition terminates in front in a tapering tongue, *B*, in the filed grooves of which the oil flows out to be blown away in separate thin sprays by the steam that streams out from underneath this tongue. The intervals between the sprays of oil serve to facilitate the access of air. The flow of oil and steam is regulated by the circular slides *C C*, which are pressed by spiral springs against the inner walls of the cylindrical sprinkler. A spigot fastened eccentrically in the axle of the spindle *D* grasps each slide. The spindles *D* are firmly packed at *E* against the partition and terminate outside the sprinkler with a square section, so that they can be turned by keys, and can thus effect the displacement of the slides. Should the flow of the oil-residue be stopped up the oil-pipe is shut off, and the tap *F* is opened, and the tongue-openings are then blown through. When a thorough cleaning is necessary, the cover *G* is unscrewed. With this device the trouble was that the fire-box was not uniformly heated, and combustion was therefore imperfect. The flame was kept too much together, and soon destroyed the walls and the ends of the pipes.

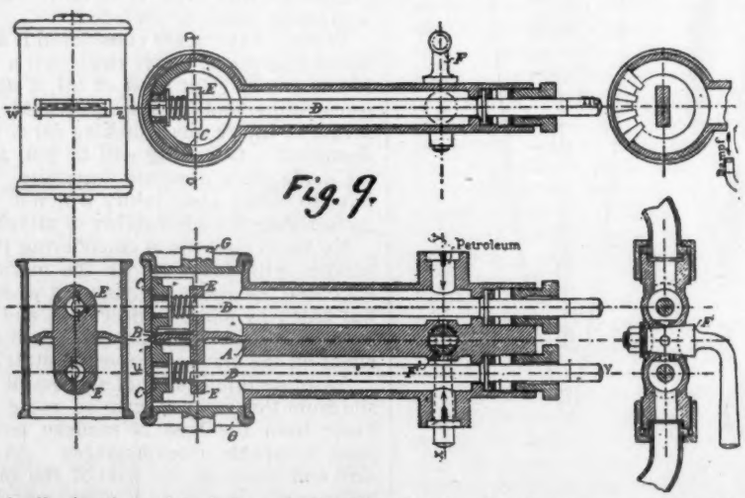


Fig. 9.

To obviate these difficulties, Lenz introduced a new form, shown in fig. 10. In this there is a circular opening round the cylindrical chamber instead of a straight slit. The

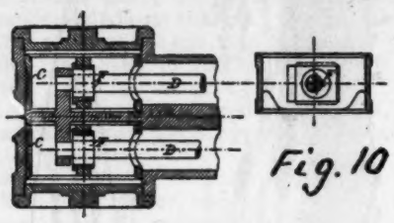


Fig. 10

slides *C C* are also made cylindrical, and are movable in the chamber. The tongue was also altered so as to obtain a broader flame, but the arrangement of the rest of the sprinkler remained the same. This modification worked much better than the first plan.

The slit sprinkler of Körting (fig. 11) was made in 1872, and worked with air, which was compressed in a specially constructed steam jet apparatus. The compressed air was conducted into the sprinkler by means of tubing and was divided by a partition into two flat currents, above and below which the slits for the oil were placed. The cut

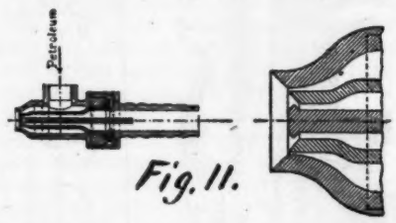


Fig. 11.

shows separately the mouth of the sprinkler, full size; it will be seen that the slits are very narrow, and in practice they were frequently stopped up. The sprinkler could not be cleaned without being taken completely to pieces, which entailed considerable delay, for which reason Körting abandoned it finally for another plan.

The slit sprinkler of Artemev, introduced in 1878, was simpler than that of Lenz; it is shown in fig. 12. The steam and oil are conducted in separate pipes to the semi-circular slit, the tongue of which is formed by a disk sharpened at its edge; this disk is held in place by a single bolt. The sprinkler is bolted to the boiler by the castings *A A*, in which it can revolve. It is also provided with a blow-cock, *B*, and can be taken apart and cleaned in a very short time.

The slit sprinkler of Karapetov, which was used espe-

cially in locomotives, is shown in fig. 13. It consists of a central body with three channels, the upper one conducting oil, the central one air, and the lower one steam. The

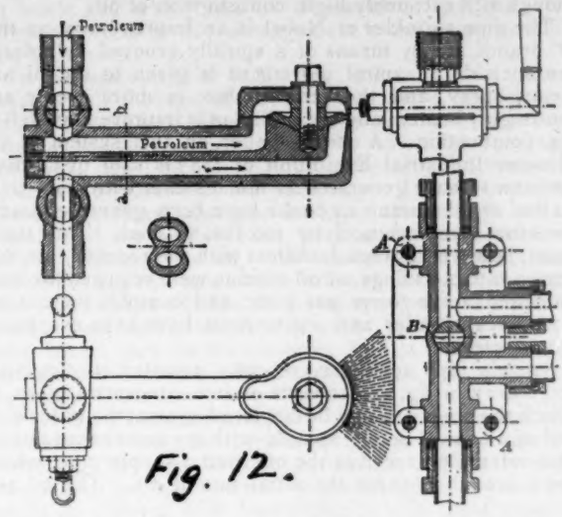


Fig. 12.

steam jet draws the air through the central channel and brings it to bear on the drops of oil to be consumed. The supply of oil is regulated by a slide and hand-wheel; the

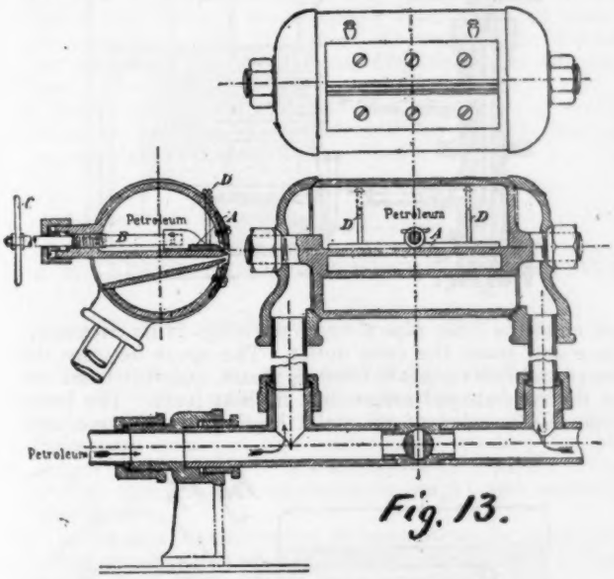


Fig. 13.

steam by a valve. By this sprinkler the jet of burning oil is thrown down against a fire-brick floor in the fire-box, and does not strike the iron plates directly.

In Brandt's sprinkler (fig. 14) the oil is brought through a central pipe and passes into the large part, *A*, of the exit chamber, which is divided into two parts, steam being introduced into the smaller section of the chamber. The oil flows through the openings *C C* into the compartments *F F*, formed by the ribs *E E*, and is thrown out in small streams through the openings *G G*. It was claimed for this device that it filled the fire-box with flame, as shown in fig. 15, insuring even heating. The chief objection to it was the difficulty of getting at it when it was clogged or needed repairs. It was impossible to reach it until the boiler was cooled down.

Jensen's slit sprinkler was tried in 1883 with some success. It is shown in fig. 16, but was afterward slightly modified, making the steam and oil jets meet at an angle of 45°, instead of issuing in parallel lines, as shown.

Herr Busley thinks that slit sprinklers entail so much waste of oil that their use is only possible in oil regions where the fuel costs little or nothing. For marine boilers there is also the drawback that for the water jets or sprays fresh water must be used. The great disadvantage, however, is the constant tendency of the slits or openings to clog and stop up. It also sometimes happens that a sudden draft will blow out the flame, and this causes an ac-

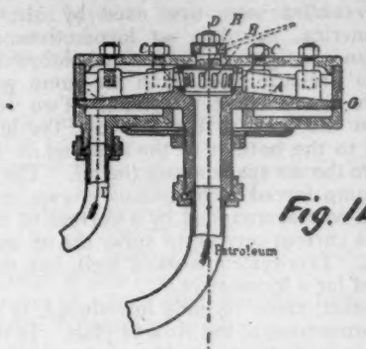
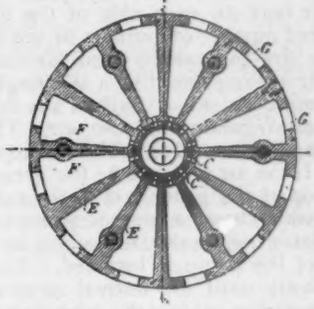


Fig. 14.



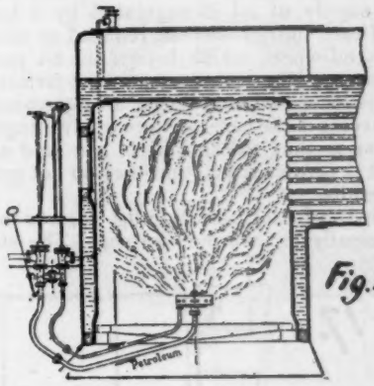


Fig. 15.

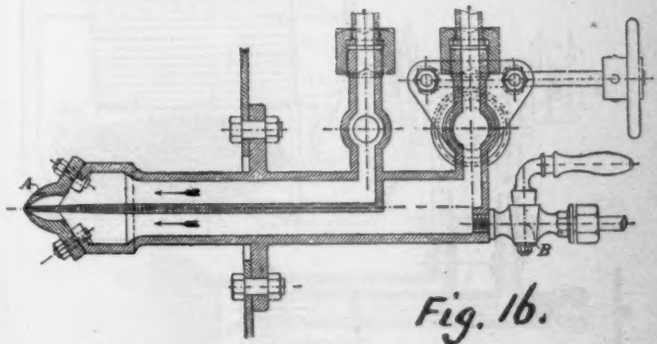
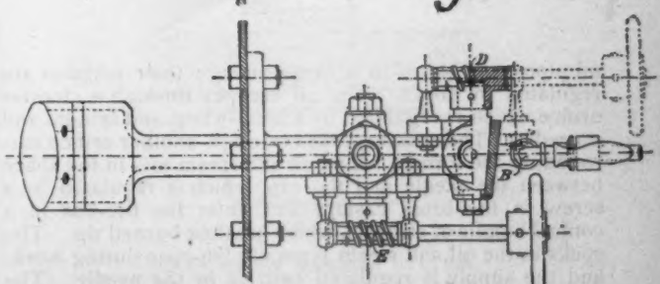


Fig. 16.



cumulation of carbonized oil residuum in the slots, so that the sprinkler must be cleaned out. It must be remem-

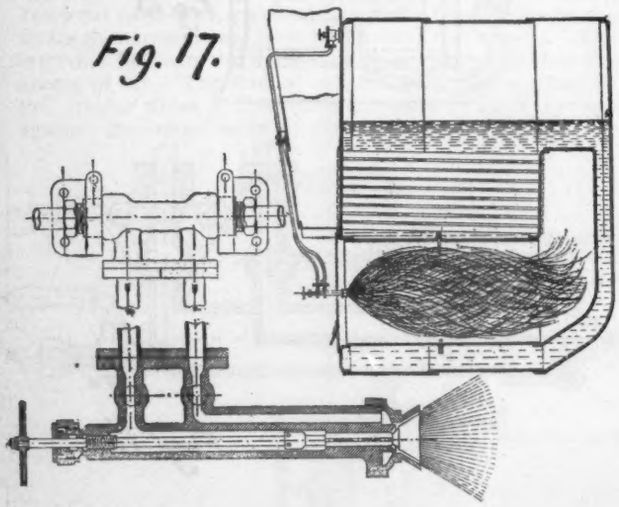
bered also that in these cases the abrupt stoppage of the fire causes sudden cooling of the plates, which is very injurious.

2. *Pipe Sprinklers* were first used by Mr. Brydges Adams in America, in 1863, on locomotives. In his arrangement an air-tight oil tank was placed near the boiler, and the pressure pipe of an air-pump was introduced through the cover of this tank. Two concentric pipes led from the tank to the fire-box; the inner pipe reached down to the bottom of the tank, while the outer one opened into the air space above the oil. The pressure from the air-pump forced a continuous stream of oil into the pipe, which was surrounded by a current of air in the outer pipe, this current serving to spray the oil and insure its combustion. This system worked well, but was found too complicated for a locomotive.

Bullard's system, more recently introduced, is a modification and improvement of the Adams plan. In this there is an oil and air tank on each side of the fire-box, with which any desired number of burners in the fire box communicate. The fire-box can be used for coal when preferred. The air is compressed by a Westinghouse pump. A noteworthy improvement of Bullard's is the simple and practical pressure-regulator for the air. The air as it enters presses against a valve, which is kept down by a spiral spring. If the air pressure be too great the valve is lifted; at the top of the piston-rod of the valve a toothed rod is fastened which turns a toothed sector on the axle of the steam regulator tap, so that the supply of steam to the steam cylinder of the pump is lessened. The pump now works more slowly until the normal pressure is again reached, and the spring presses the valve down into its old place. The supply of oil is regulated by a ball valve. The flame of each burner can be reduced or enlarged by means of a hand-wheel, which brings the oil pipe nearer or takes it farther away, as desired. In the former case the supply of oil is increased and that of air decreased; in the latter the converse is the case. A great advantage claimed by this system is that the sprinklers are said not to get heated, and it is further stated that they do not get stopped up with oil residue.

Brandt's pipe sprinkler, shown in fig. 17, was introduced in 1880, principally for marine engines. The steam and

Fig. 17.

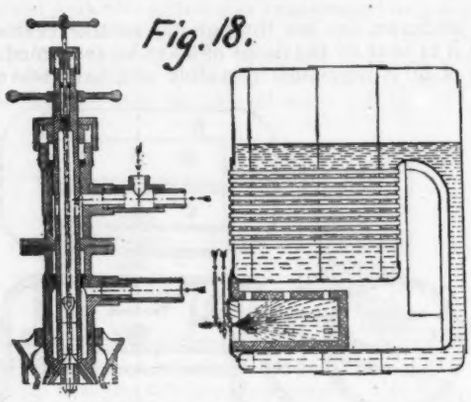


oil pipes are united in a brass casing; their supplies are regulated by cocks. The oil escapes through a circular orifice which is regulated by a hand-wheel and spindle and a needle. The steam escapes through another orifice surrounding the former. The oil and steam mix in the space between the needle and the cap, which is regulated by a screw in the brass casing, and enter the fire-box in a conical bundle of streams, which are then burned up. The cocks in the oil and steam pipes are left open during work, and the supply is regulated entirely by the needle. The sprinkler is so constructed that it can be turned out of the fire-box, the cap can be removed, and the entire apparatus thoroughly cleaned. The requisite air enters through holes in the door and the ash valve in the fire-box. This sprinkler is preferable to slit sprinklers, inasmuch as it heats the fire-box more evenly, and entails a smaller, though still extremely high, consumption of oil.

The pipe sprinkler of Nobel is an improvement on that of Brandt, as, by means of a spirally grooved cylinder in the sprinkler, a spiral movement is given to the oil and steam spray, and thus the fire-box is more evenly and thoroughly heated, and the radiation is improved, as well as the combustion. A steam boiler on this system at the Moscow Industrial Exhibition of 1883 is said by Garlish-ambarw to have generated as much steam with from 50 to 60 lbs. of oil residue as could have been generated under the same circumstances by 100 lbs. of coal. This statement, however, agrees doubtless with the reputed fact that from 2.0 to 2.8 kilogs. of oil residue were required for each indicated horse-power per hour, and compels the conclusion that the boiler and engine must have been exceptionally efficient.

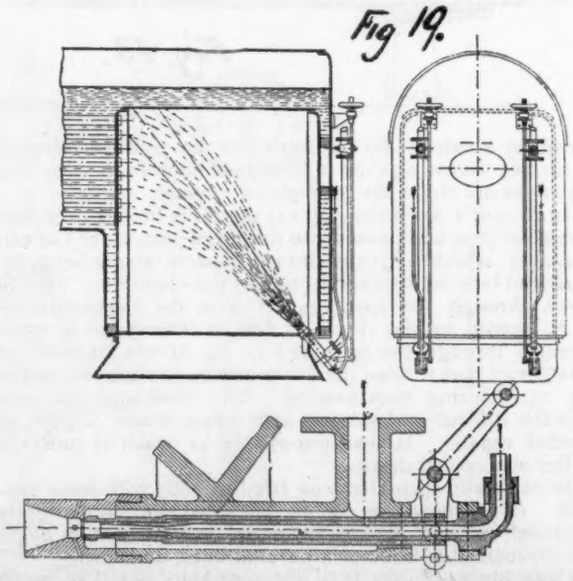
Smith's pipe sprinkler, recently patented in England, and shown in fig. 18, consists of two concentric pipes, of which the inner one can be displaced against the outer one, and of a central screw spindle with a cone-shaped outlet. The outer pipe receives the oil from a supply pipe, which has a branch pipe for the admission of air. The oil and

Fig. 18.



air enter the inner pipe through openings in its circumference and reach the cone outlet. The space between the outer and inner pipes is filled by steam, which streams out of the cone-shaped outlet in a circular form. The inner pipe has a valve at its outlet leading to the cone, and

Fig 19.



leaves circular slits for the escape of the oil and air as the central spindle keeps turning. In a similar manner the expansion of the inner pipe and the contraction of the outer pipe act like a cone-valve when the inner pipe is displaced

by means of a hand-wheel, and the escape of steam is thus regulated. A hollow cone is screwed over the outlet, which enables the air to be sucked up while the spindle is at work, and which can be displaced as required. The great objection to this arrangement is the complication of the apparatus.

In the pipe sprinkler of Korting, shown in fig. 19, steam was carried through the inner pipe, while the oil is fed through the outer pipe. The supply of steam was regulated by a lever and hand-wheel, by which the opening at the nozzle could be increased or decreased, and the supply of oil was regulated in the same way. The oil and steam spray as it leaves the pipe sucks in air through holes in the side of the outflow cone, thus increasing combustion on the surface of the oil. Air was also admitted through the ash-pan. In a locomotive boiler the flame was directed upward, as shown in the cut; this was found to injure the crown-sheet and tube-plate. In marine boilers the flame was thrown back on the fire-brick bridge. This sprinkler had the merit of simplicity in construction, and it could also be easily cleaned.

Pipe sprinklers in use have proved themselves more economical than slit sprinklers, and they also use less steam. They are, like slit sprinklers, subject to being stopped up by residuum and impurities, but they can generally be cleaned with less difficulty. In most cases the mouthpieces can be removed and thus cleaned with very little delay. The main advantage of the pipe sprinkler consists in the fact that the flame is generally spherical, and thus, in marine boilers, fills up the cylindrical fire-box better, and heats it more equally than the flame from a slit sprinkler. This also saves the walls of the fire-box and makes the use of additional fire-brick walls unnecessary. This effects some saving.

Both pipe and slit sprinklers, however, have generally given way to the nozzle sprinklers, which form the last and largest class to be described.

(TO BE CONTINUED.)

A SWEDISH FAST PASSENGER LOCOMOTIVE.

(Translated from the *Revue Generale des Chemins de Fer.*)

THE management of the Swedish State Railroads operated in 1886 a total of 2,469 kilometers of railroad of standard gauge (4 ft. 8½ in.), in the train service of which there were employed 334 locomotives, including 146 passenger engines; 149 freight engines with separate tender, and 39 tank engines employed in freight and switching service.

In the recent construction of locomotives for these lines, under the direction of Mr. Almgren, several new devices, which are of interest, have been introduced.

These innovations have been for the most part used in the building of locomotives for the fast passenger trains, a new type of which has been introduced. Seven of these locomotives were completed at the shops at Trollhattan in 1886, and have since been in service, and 10 more are now under construction at the same place.

These locomotives are the heaviest passenger engines ever put in service on the Swedish lines; they have cylinders 16½ in. in diameter, and 22-in. stroke, four coupled drivers 74 in. in diameter, and a truck of the Bissell pattern with four wheels 43 in. in diameter. The accompanying illustrations show a longitudinal section, a plan, and four half cross-sections of the engine, and the general construction and arrangement can readily be seen from them. The dimensions of the boiler and fire-box are given in the table below:

DIMENSIONS OF BOILER:

	Ft.	In.
Length of barrel	12	9½
Diameter of barrel	3	10¾
Thickness of plates of barrel	0	0½
" smoke-box tube-plate	0	0 13/16
Seams, double-riveted, lap	0	3½
Space between rivets, centers	0	3
Diameter of rivets	0	0⅞
Outside fire-box plates, thickness	0	0 9/16
Distance between stay-bolts, centers	0	4
Diameter of stay-bolts	0	1

Material of boiler shell, iron.

FIRE-BOX:

Length, inside, at bottom		7	0½
Width "		3	0⅛
Height at front end		5	1¼
" rear end		2	10⅞
Thickness of side-sheets		0	0 9/16
" crown sheet		0	0⅝
" tube-sheet		0	1⅛

Material of fire-box, copper.

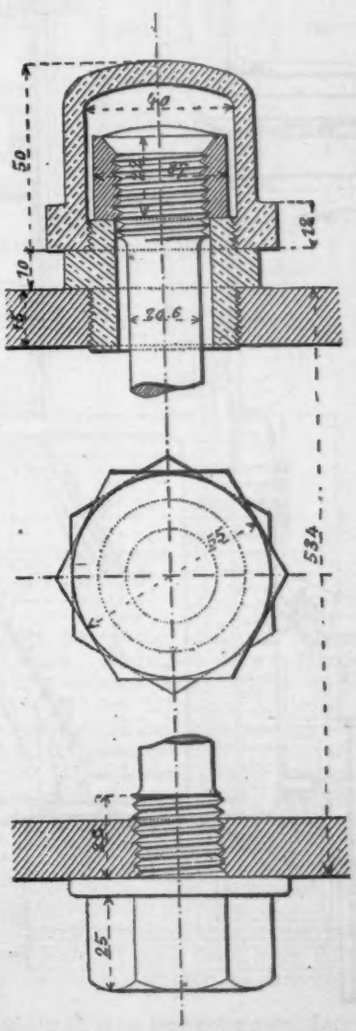
Number of tubes, 130; material, iron.

Outside diameter of tubes		0	2
Length		13	3½
Grate surface	22.61 sq. ft.		
Heating surface: Firebox	85 04 "		
" " Tubes	891.28 "		
Total	976.32 "		

(The dimensions given in the cut are in meters and millimeters).

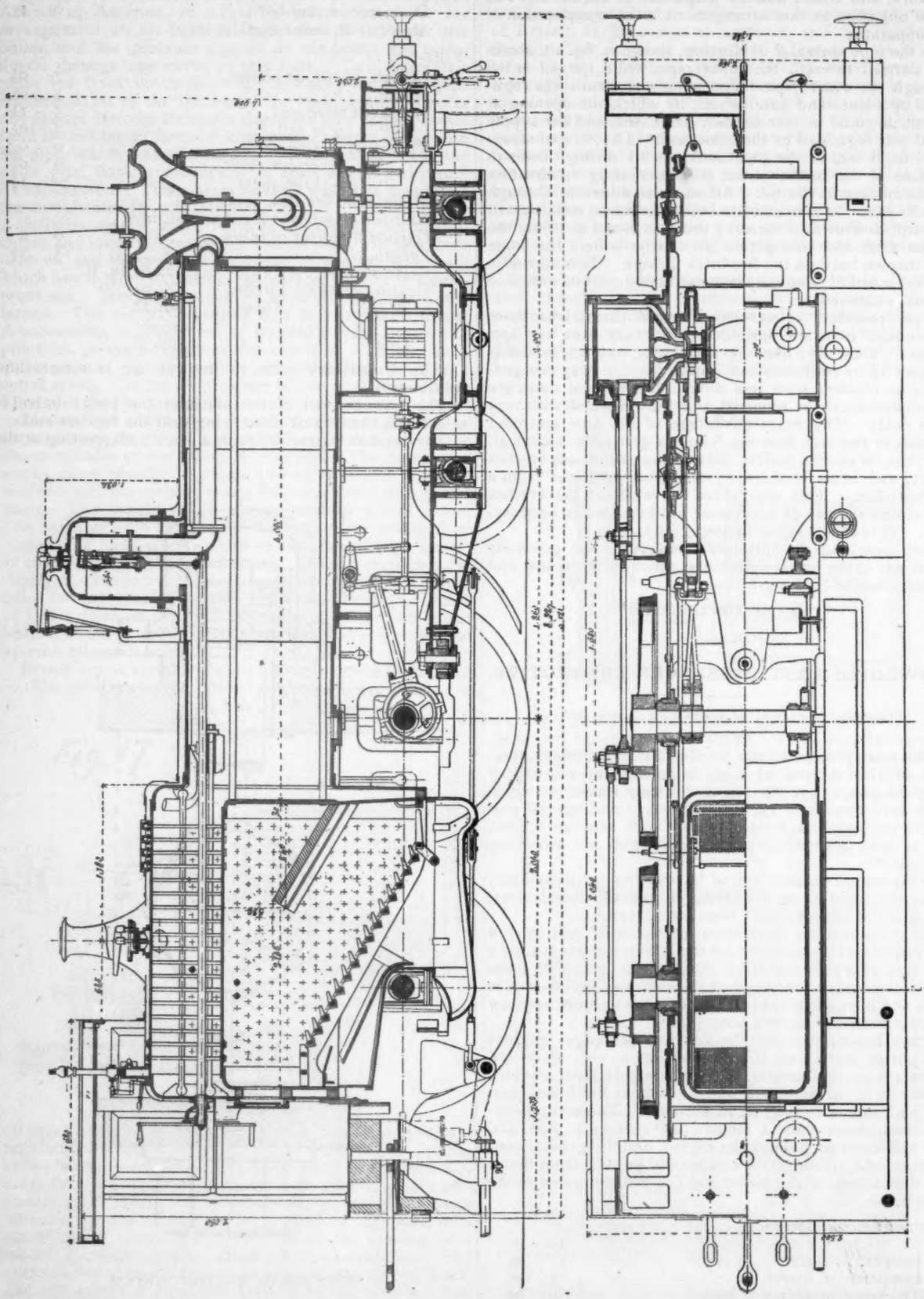
The arrangement of the plates of the boiler barrel is telescopic, the largest plate being next the fire-box end.

The fire-box is provided with a brick arch, resting at the



STAY-BOLTS, YARROW SYSTEM.

ends on brackets riveted to the side plates. The crown-sheet of the fire-box is joined to the outer crown-sheet by long stay-bolts of iron of the ordinary form, except that



FAST PASSENGER LOCOMOTIVE, SWEDISH STATE RAILROADS.
(Dimensions in Meters and Millimeters.)

four rows at the front end of the fire-box are stay-bolts of the Yarrow system. These stay-bolts, as shown in the accompanying cut, are fastened at one end in the fire-box crown-sheet and at the other end are allowed to work freely through a hollow plug screwed into the outer sheet. The end of the stay-bolt is riveted on a washer which bears upon the upper end of this plug; the latter has a screw thread upon it, upon which is screwed a cap which prevents any escape of steam. It is claimed for these stay-bolts that a certain amount of motion is allowed which prevents the stripping of the thread and diminishes the strain which the expansion and contraction of the fire-box imposes on stay-bolts of the ordinary pattern.

The grate of the fire-box is composed of 15 iron bars resting on brackets, these brackets forming a sort of staircase inclined at an angle of 28°. The bars are furnished with a series of projections (somewhat like the shaking grates used in this country), those on each bar extending over the bar below, as is shown in the cut.

In this way a grate has been made in steps, of a form which favors the abundant passage of air, which is indispensable in order to burn completely the Swedish coal. This coal is mined from a comparatively recent geological formation, and contains 20 per cent. of cinder. The mixture actually burned in these fire-boxes is composed of English and Swedish coal, in equal parts, but it is expected that the proportion of Swedish coal will be gradually increased until it is four-fifths of the whole.

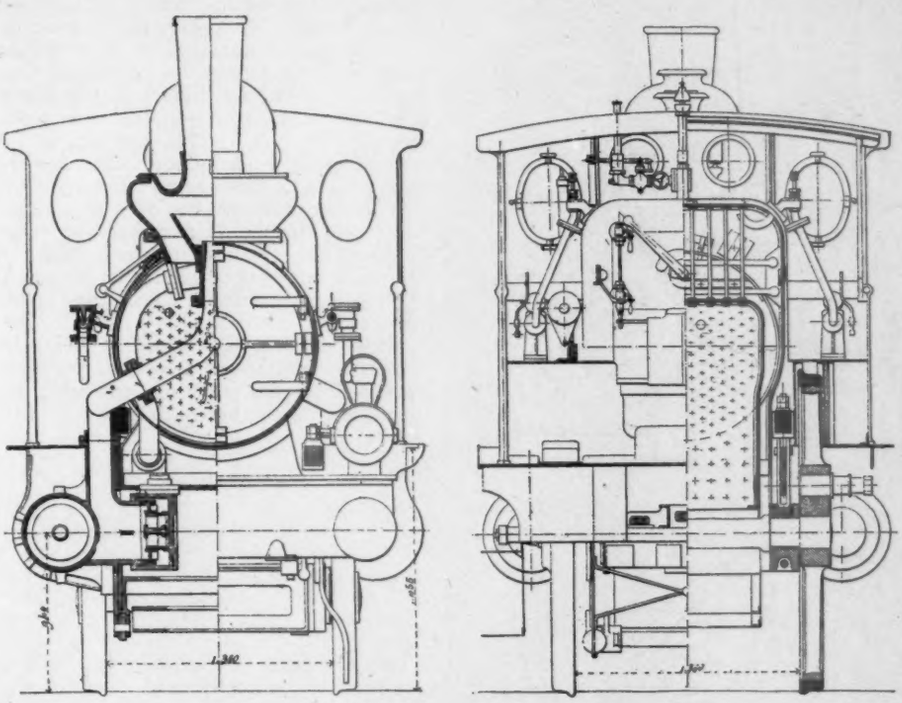
At the foot of this inclined grate, at the forward end of the fire-box, is a plate composed of bars or fingers carried upon an iron bar across the fire-box, which serves the same purpose as the dead plate or dump grate frequently used in our own engines burning bituminous coal. In front of this and against the forward part of the fire-box is placed a single bar with numerous openings, insuring an abundant supply of air in that portion of the fire-box.

The ash-pan is very large, and is made of the form shown to permit the placing of the rear driving axle under the fire-box. A double plate with air spaces is used to protect the axle from the heat.

The tubes are of iron. Before putting them in place their ends are slowly heated to a red heat, and then cooled off in slaked lime, which renders them ductile. The end which enters the fire-box tube-plate is then drawn down from 50 to 47 millimeters in diameter. The hole in the tube-plate is made 48 millimeters in diameter; the tube when in place is brought into perfect contact with the plate by an expander, and is then riveted over and a ferrule put in. At the smoke-box end the tube is left at its original diameter, the holes in the tube-plate being made 51 millimeters; the tube is then expanded into perfect contact with the plate, but is not riveted or provided with a ferrule.

The steam dome is placed at about the middle of the barrel of the boiler, as shown in the engraving; it carries two safety-valves of the Meggenhoffen system.

The throttle is a valve which moves vertically on the face of the head of the cast-iron steam-pipe; to facilitate the movement of the large valve, an auxiliary valve is provided, which, by a slight movement produced at the moment when the throttle is opened, uncovers a small opening, permitting the steam to enter before the large valve moves. The engineer moves the throttle-valve by giving a rotary movement to a handle which communicates through a rod with a lever attached to the valve.



FAST PASSENGER LOCOMOTIVE, SWEDISH STATE RAILROADS.

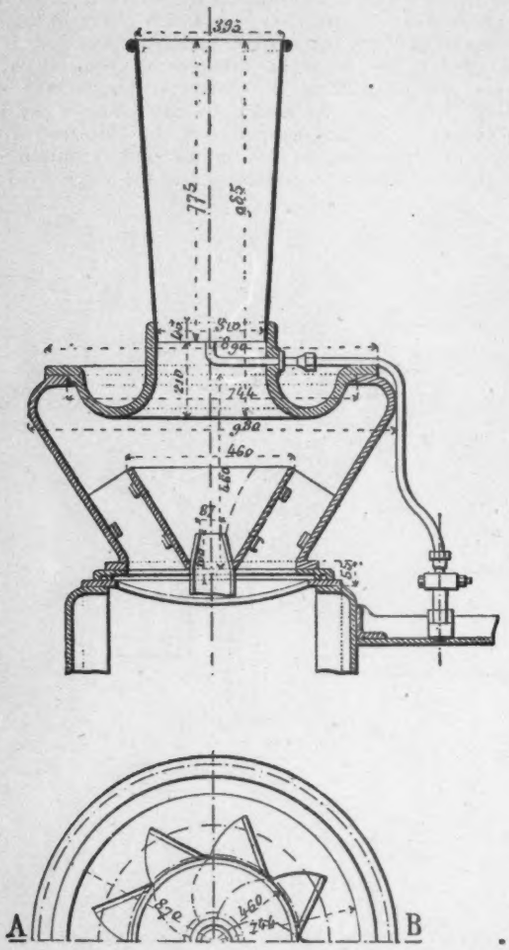
(*Dimensions in Meters and Millimeters.*)

The cylinders are placed outside, between the two wheels of the truck. The steam chest is placed inside and is provided with a balanced valve, similar to those used on the locomotives of the Northern Railroad of France. These valves are made of cast iron, and are formed by two flat valves or tables provided with cylindrical parts fitting into each other. The inner cylinder carries a cast-iron segment which makes a joint with the outer one. A coiled spring bearing on the bottom of each of these cylinders tends to separate the two parts of the valve and to make them bear one on the valve face, the other to the cover of the steam chest. The interior of the valve communicates directly with the exhaust.

The guide-bars are of steel cast at the Bofors factory. The cross-heads are of mild steel from the Trollhattan forges. The valves are worked by straight links of the Allan system.

The frames are of mild Bessemer steel furnished by the mills at Donmarfvet in Dalecarlia. At the rear end the weight rests on the coupled axles through springs and equalizers, by which it is distributed equally upon the wheels. The forward end is carried on the truck, as shown in the engraving.

The smoke-stack is, to our eyes, of a very peculiar form. There is a straight chimney of sheet iron of the form commonly used in Europe, but this is attached to a cast-iron base which rests directly on the smoke-box. In this base, which has the form of a reversed cone, is a second cone, the center of which is directly over the exhaust nozzle; between these two cones there is a series of curved arms very similar to the wings of a turbine. These throw the cinders against the side of the base, and they then fall back into the smoke-box. To American eyes the whole



SMOKE-STACK FOR SWEDISH LOCOMOTIVE.

arrangement seems very much like one of our diamond stacks turned upside down, with the cone at the bottom of the stack instead of the upper end. It is said, however, to give very good results.

The truck is carried upon two axles and is on Kamper's modification of the Bissell system, which is used extensively on the engines of the Franz-Josef Railroad in Austria. The center for the radius-bar is placed behind the axles, and is formed by a pin passing through a bar and having a longitudinal motion between two slides which are carried by cross-braces connecting the frames. The construction of the truck as shown in the drawing will appear to American eyes somewhat awkward and clumsy. As its motion is limited by the radius-bar at the rear end, it is regulated in front by links which are connected to lugs fastened to the bumper-bar at the front end of the frames. The weight which rests upon the truck is carried by side-bearings so arranged that it will be equally distributed.

The wheels are of wrought iron; the driving wheels are provided with counterbalances in the usual manner.

The axles are of puddled steel, made at the Surahammar shops.

The tires are of Bessemer steel made at Sandviken. Those that are used on the wheels which are exposed to the action of the brake-shoes have a somewhat smaller proportion of carbon than the others.

The axle-boxes are so made that the lubrication is entirely from above. On these engines Russian oil is used altogether. The axle-boxes are made of steel from Bofors; the pedestal jaws in which the boxes are carried are also of steel.

The driving wheels of the engine are provided with vacuum brakes of the Koerting-Sanders system. The locomotives are also provided with a counter-pressure brake system for emergencies, which is, however, very seldom used.

The total weight of these engines, when the boilers are full and ready for service, is 40.4 tons; of this 15 tons are carried on a truck and 25.4 tons on the driving wheels.

In actual service the engines first built of this pattern run between Malmo and Nassjo, making the distance from Malmo to Stockholm, which is 384 miles, in 14½ hours, with 13 stops. The average speed, making no allowance for the time lost in stopping, is about 26½ miles an hour, the usual train consisting of 12 carriages and wagons, weighing in all about 130 tons. In the summer season, however, the train is sometimes increased to 15 carriages weighing 157 tons. The limit of speed imposed on these engines is 46⅓ miles an hour, although one or two of them have attained a speed of 50 miles upon occasion.

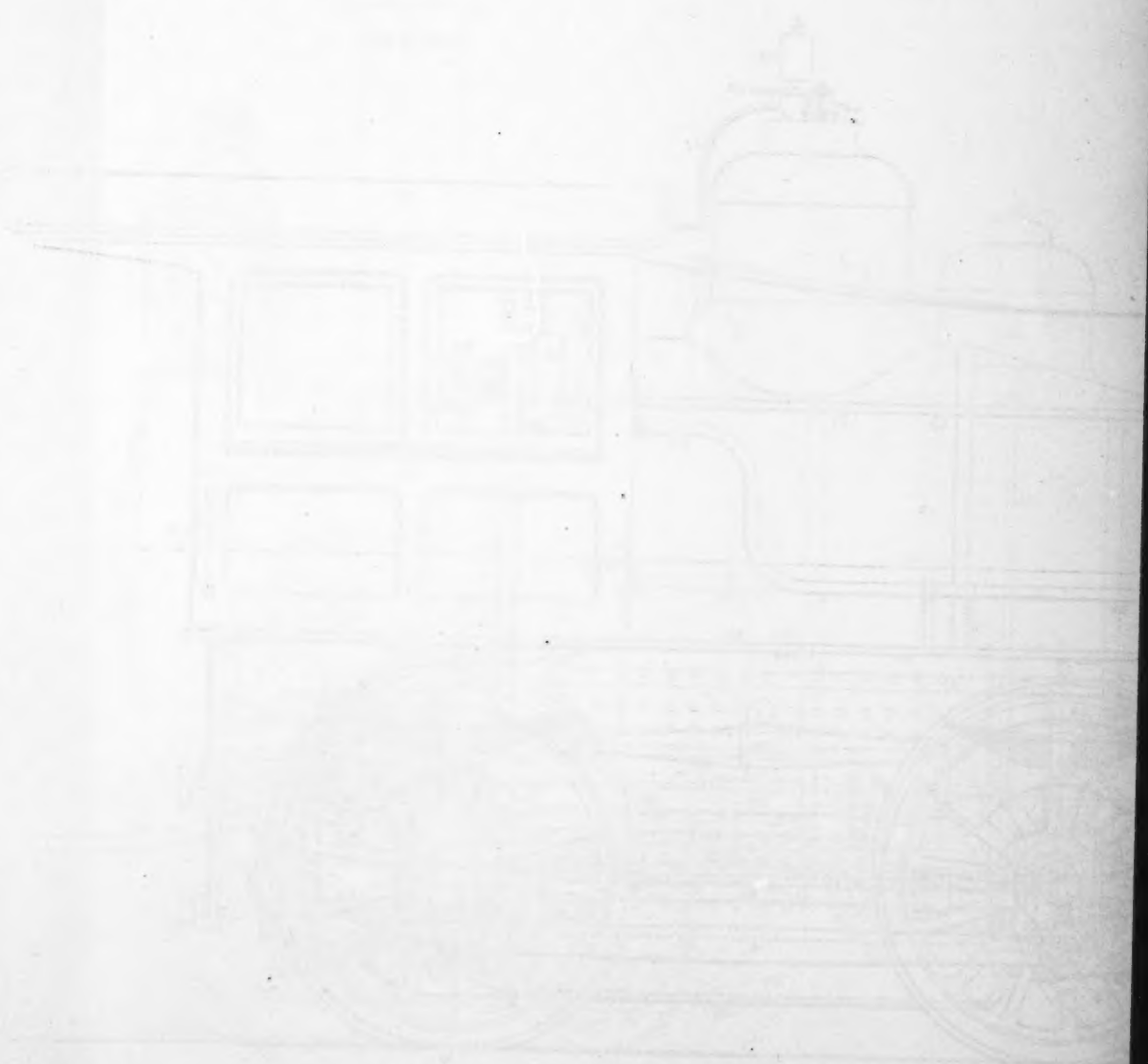
While the average speed is, as above stated, only 26½ miles per hour, it is necessary at various points of an ordinary run, in order to make time, to reach a speed varying from 31 to 37½ miles an hour. The usual service of a locomotive is about 2,600 miles in winter and 3,700 in summer.

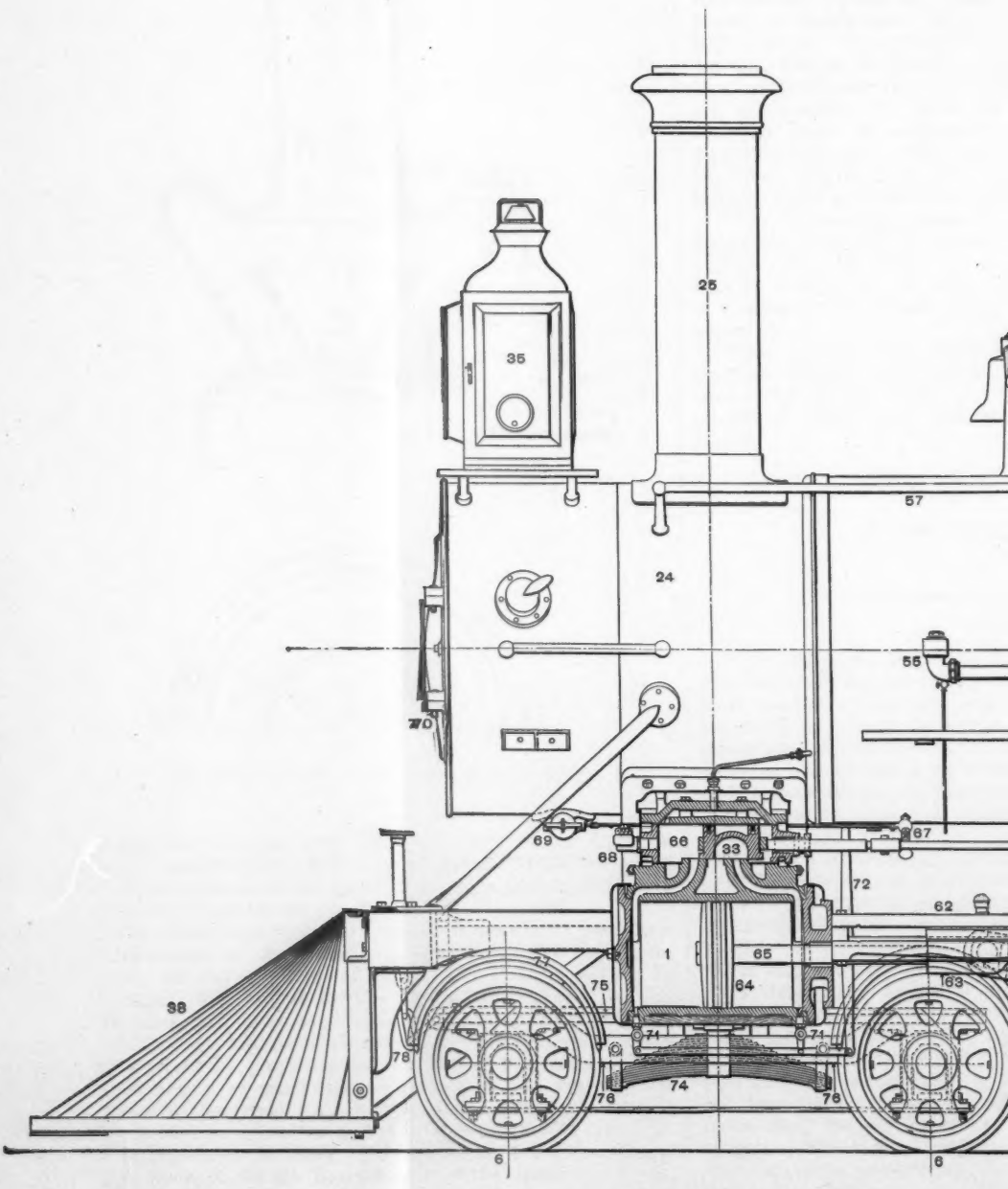
These engines have done excellent service, and since they were built have proved themselves easy upon the track and steady running engines; they pass around curves, of which there are many on the line, with great facility.

A New Dynamite Gun.

(From the *Army and Navy Register.*)

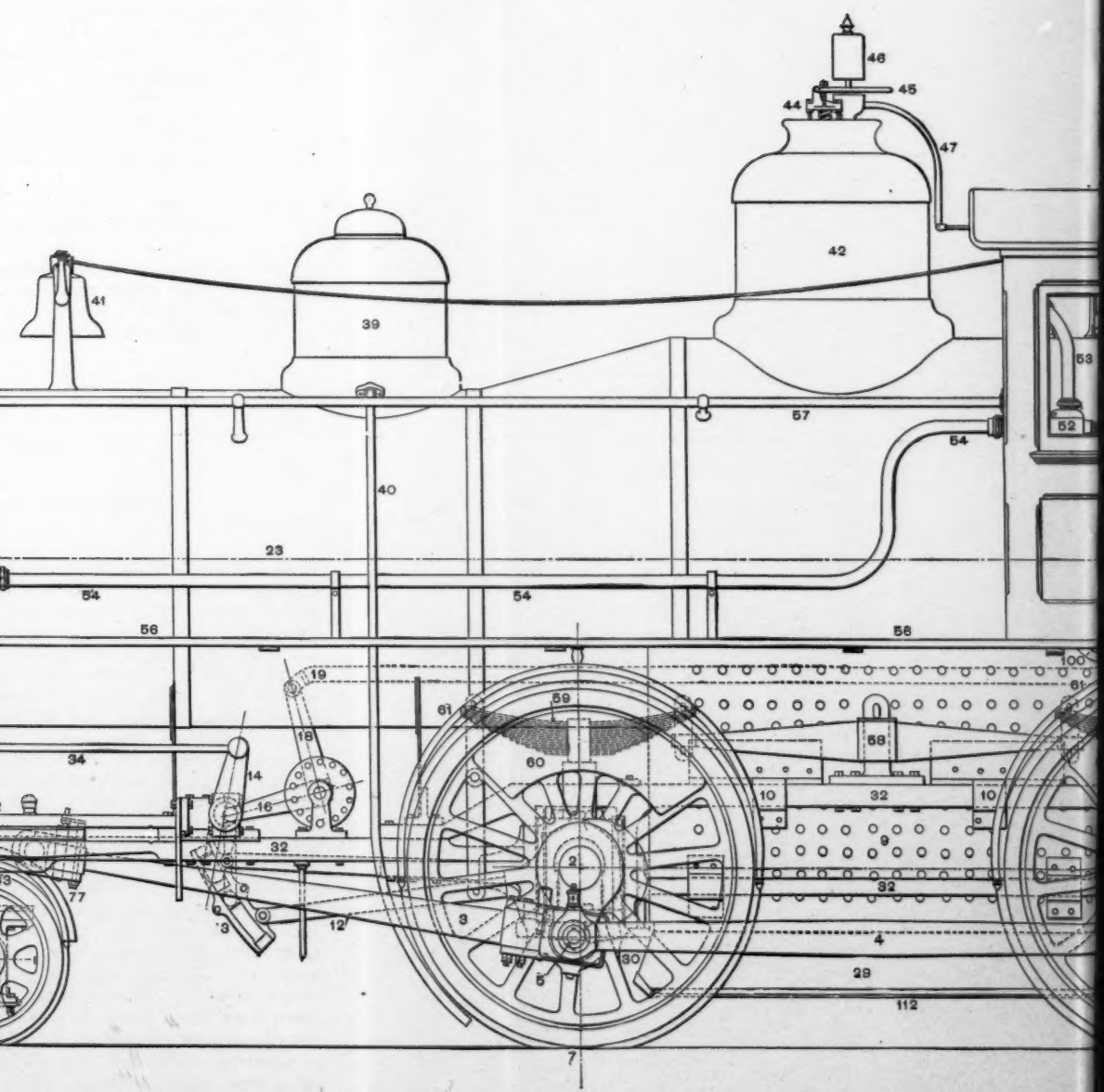
THE Ordnance Department of the Army has this week received from the celebrated inventor, Mr. Maxim, of England, the description of a new dynamite gun which he has projected, in which he proposes to introduce a new and interesting method of expelling the projectiles from the weapon, and by which he hopes to render the use of dynamite in projectiles practicable in heavy guns. He retains the pneumatic principle which has been utilized with so much success by Captain Zalinski, but instead of using compressed air alone, as Captain Zalinski has done, he mixes with this compressed air a quantity of volatile hydrocarbon, such as the vapor of gasoline. This compressed mixture is introduced behind the projectile and the pressure is applied to start it forward in the chamber of the gun. After it has moved a certain distance the projectile itself uncovers a detonating fuse and an explosion then occurs, the air furnishing the oxygen for the explosion and the pressure being increased about eight times. He claims that by this method his initial pressure does not need to be more than half as great as that used by Captain Zalinski. He does not have to use so much compressed air, nor does he require that the barrel of his gun shall be of such great length. His highest pressure is about 4,000 lbs. to the inch, the first pressure being not more than one-tenth of that. His detonator is a very ingenious affair, and is inserted through a small circular opening from the interior of the gun. The ordnance officers are much interested in this new form of the dynamite gun, which is first brought to public notice, we believe, in this article.





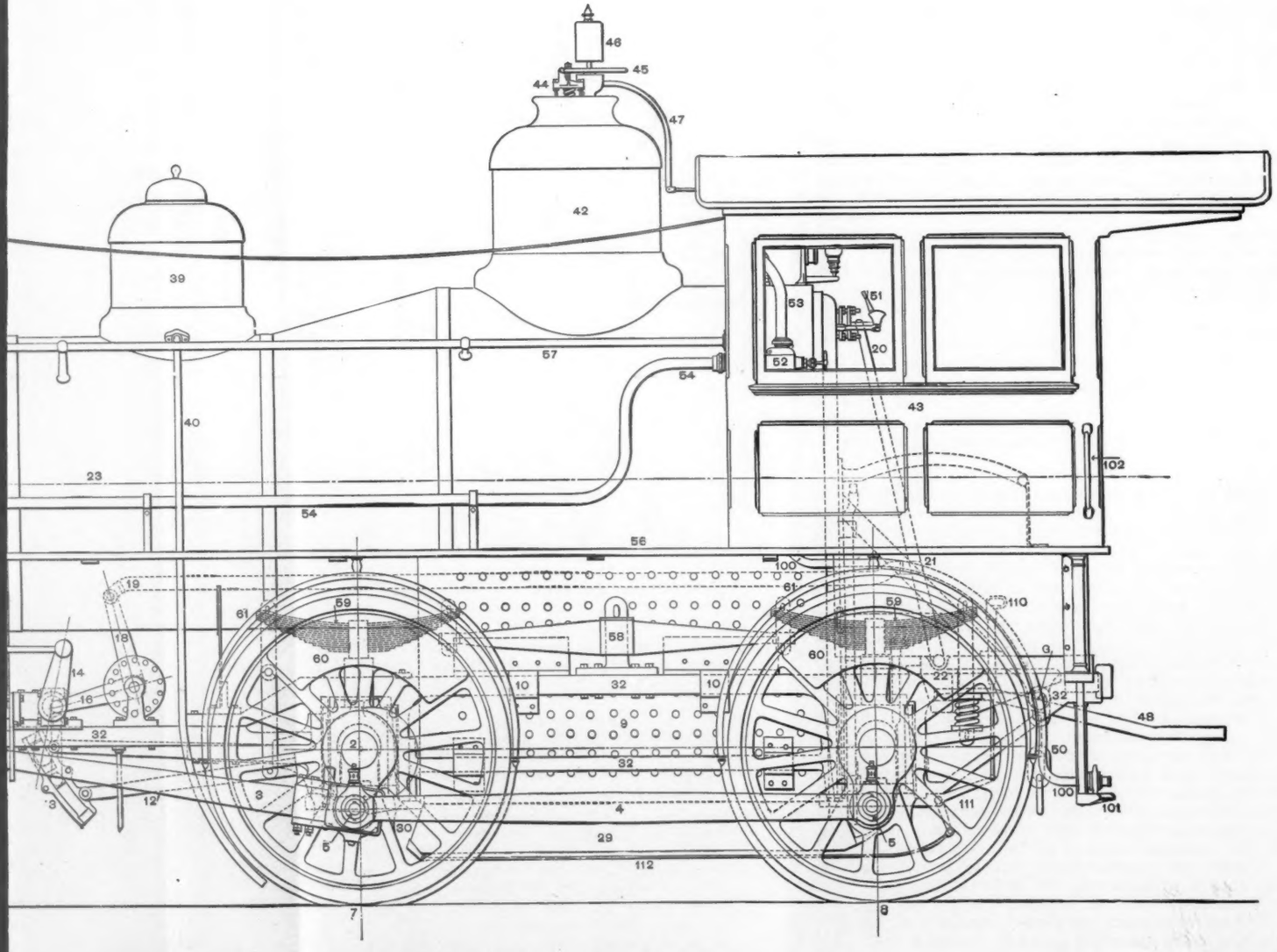
PASSENGER LOCOMOTIVE

PLATE III.



TIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

PLATE III.



BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(Copyright, 1887, by M. N. Forney.)

(Continued from page 184.)

CHAPTER XI.

GENERAL DESCRIPTION OF A LOCOMOTIVE ENGINE.

Question 273. *What are the principal parts of an ordinary locomotive engine?*

Answer. A boiler for generating steam and a pair of high-pressure steam-engines, which are all mounted on a suitable frame and wheels adapted for running on a track consisting of two iron or steel rails.

Question 274. *How is the power of high-pressure engines applied to locomotives?*

Answer. By connecting the engines with the wheels so as to give the latter a rotary motion.

Question 275. *When they revolve what will occur?*

Answer. Either they will slip on the track, or the locomotive will move either backward or forward, according to the direction the wheels are turning.

Question 276. *What will determine whether the wheels will slip or the locomotive move?*

Answer. The friction or *adhesion*, as it is called, between the wheels and the track. If this adhesion is greater than the resistance opposed to the movement of the locomotive, the latter will overcome the resistance; but if the latter is greater than the friction, the wheels will slip.

Question 277. *Upon what does the amount of friction or adhesion of the wheels depend?*

Answer. Chiefly on the weight which they bear, but to some extent upon the condition of the rails. Under ordinary circumstances, the adhesion of the wheels of a locomotive is in direct proportion to the weight they carry.

Question 278. *Why are two cylinders employed on locomotives?*

Answer. Because if only one was used, it would be impossible or very difficult to start the engine, if it should stop on one of the dead points.

Question 279. *How is this difficulty overcome by the use of two cylinders?*

Answer. By attaching the two cranks to the same shaft or axle, and placing them at right angles to each other, so that when the one is at a dead point the other is in the position where the steam can exert the maximum power on the crank.

Question 280. *How are the cranks of an ordinary locomotive made?*

Answer. They are cast in one piece with the wheels that drive the locomotive, which are therefore called *driving-wheels*. In this country the center portion of such wheels, or *wheel-centers*, as they are called, is always made of cast iron. They are bored out accurately so as to fit the axles, which are forced into the holes bored to receive them. The centers are keyed fast to the axles, so as to prevent them from turning. The wheel-centers have steel tires around the outside which are accurately turned inside, and are made a little smaller than the wheel-centers. Before they are put on the wheels the tires are expanded by heating them, and as they cool they contract, which causes them to fit tight. The axle of a locomotive engine to which the pistons are connected is called the *main driving-axle*, and the wheels attached to it the *main driving-wheels*.

Question 281. *How are the general construction and arrangement of parts of a locomotive illustrated?*

Answer. By plates III, IV, and V, which represent a side view, a longitudinal section, and a plan of an eight-wheeled passenger engine built at the Baldwin Locomotive Works in Philadelphia, and by fig. 164, which is a transverse section through the cylinders, and fig. 165, which is an end view looking at the back end of the engine.*

Question 282. *How are the cylinders and driving-wheels of a locomotive usually placed?*

Answer. The cylinders 1, of eight-wheeled American passenger engines, plates III, IV, and V, are placed at the front end of the locomotive, and the main driving-axle, 2, far enough behind them to permit the connecting-rods, 3, to be attached to pins, 5, in the cranks, called *crank-pins*. In this country these cranks are now universally placed on the outside of the frames, and therefore the cylinders must be placed far enough apart (as shown in fig. 164 and Plate V) to permit the connecting-rods to be attached to the crank-pins. For this reason the cylinders are placed outside of the frames 32, 32, 32. The frames, it will be seen, are inside of the wheels, and the cylinders now nearly always have their axes or center-lines horizontal, although in old engines they are sometimes inclined.

Question 283. *Why are more than one pair of driving-wheels necessary for locomotives?*

Answer. Because if all the weight which is needed to create the requisite adhesion of the wheels of locomotives to pull heavy loads was placed on one pair of wheels, it would be so excessive as to partly crush and injure the rails. It is therefore distributed, usually on two pairs, but sometimes on three or four or even more pairs. The cranks in the wheels on each side of the engine are connected together by rods or bars, 4, called *coupling* or *parallel-rods*, which are attached to the crank-pins, so that all the driving-wheels will revolve together.

Question 284. *Where is the second pair of driving-wheels usually placed?*

Answer. These wheels, 8, 8—called the *back driving* or *trailing driving-wheels*—are, in the ordinary type of locomotives used in this country, situated behind the main driving-wheels, far enough back to give the room necessary for the fire-box between the two axles.

Question 285. *How are the axles, cylinders, etc., held in the right position in relation to each other?*

Answer. By longitudinal frames, 32, 32, which hold the axles in the proper position, and are bolted to the cylinders, and also fastened to the boiler at 10, 10.

Question 286. *What are the smaller wheels, 6, 6, called, and what are they for?*

Answer. They are called *truck-wheels*, and carry the weight of the cylinders and other parts of the front end of the locomotive, and serve to guide and steady the machine in a manner which will be more fully explained hereafter.

Question 287. *How is a locomotive engine made to run either backward or forward?*

Answer. By having two eccentrics, 11, 11′, plates IV and V, for each cylinder. One of these is fixed or *set* on the shaft in such a position as to move the valve so that the engine will run in one direction; the other eccentric is set so that the engine will run the reverse way. The ends of each pair of eccentric rods are attached by rods 12, 12′ to what is called a *link*, 13, the object of which is to furnish the means of quickly engaging and disengaging either eccentric rod to or from the rocker, 14, 14. The rockers are connected to the main-valves, 33, by rods, 34, called *valve-stems*. The links are suspended by bars, 15, called *link-hangers*, to the ends of arms, 16, attached to a shaft, 17, called a *lifting-shaft*. This shaft has another upright arm, 18, attached to it on the right-hand side of the engine, the upper end of which is connected by a rod, 19, 21, called the *reversing-rod*, to a lever, 20, 21, and 22, called the *reversing-lever*, in the cab. The principles and operation of this mechanism will be fully explained in another chapter.

Question 288. *What are the principal parts or "organs" of a locomotive boiler?*

Answer. 1. A fireplace, or, as it is called, a *fire-box*, 9.

2. A cylindrical part, 23, attached to the fire-box at one end and to a chamber, 24, called the *smoke-box*, at the other.

3. The *tubes* or *flues*, 25, 25′, Plate IV, which connect the fire-box with the smoke-box, and pass through the cylindrical part of the boiler and are surrounded with water.

4. The *chimney* or *smoke-stack*, 25.

Question 289. *What is each of those parts or organs for and of what do they consist?*

Answer. The fire-box 9 furnishes the room for burning the fuel, and consists of an inner and outer shell made of boiler plate, as shown in plates IV and V, with the spaces 26, 26 between the two shells filled with water; a grate, 27, 27, formed of cast-iron bars, with spaces between them for admitting air for the combustion of the fuel, which is placed on top of them; a door, 28, called the *furnace-door*, for supplying the grate with fuel; a receptace, 29, below the grate, to collect ashes, and therefore called the *ash-pan*, which is supplied with suitable dampers, 30 and 31, for admitting or excluding the air from the fire.

The cylindrical part 23, or *waist* of the boiler, as it is sometimes called, contains the greater part of the water to be heated.

The *flues* or *tubes*, as they are generally called, are usually 2 in. in diameter and from 10 to 12 ft. long. The number of tubes in a locomotive boiler varies with its size. A boiler of the size shown in the illustration has about 250 tubes. They conduct the smoke and products of combustion from the fire-box to the smoke-box. The tubes are made of small diameter so as to subdivide the smoke into many small streams and

* The same figures indicate the same parts in all these engravings.

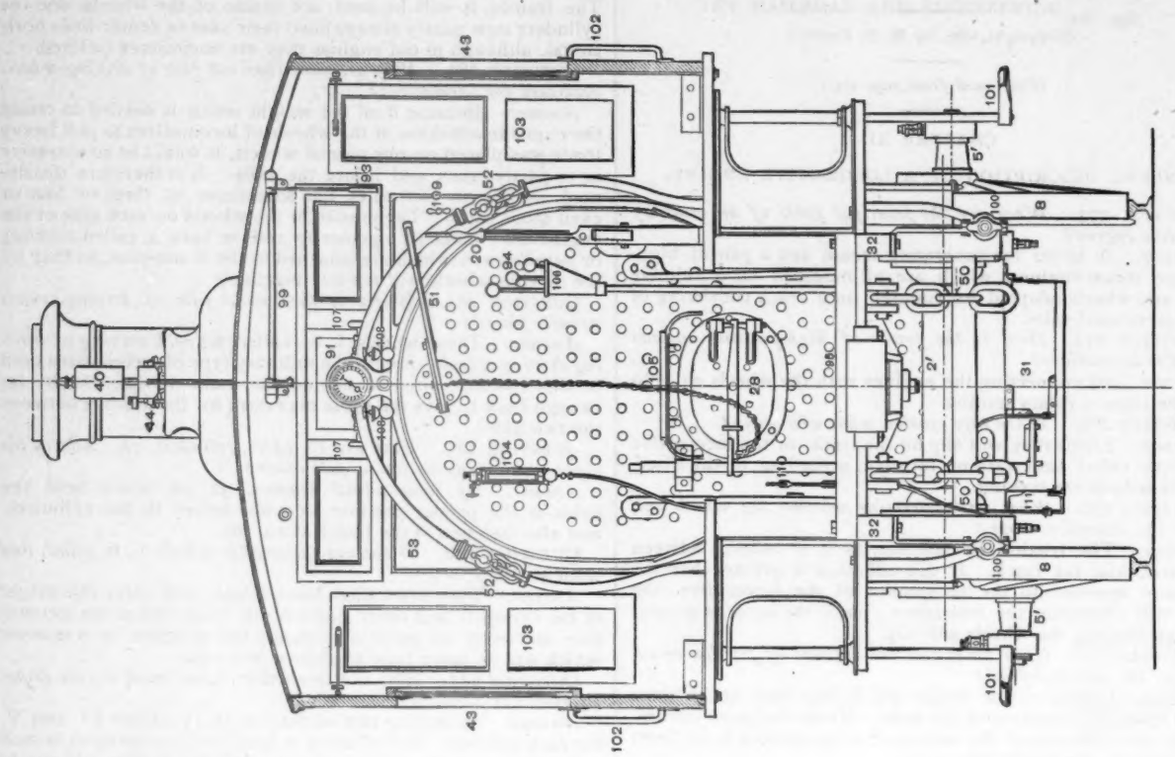


Fig. 165.

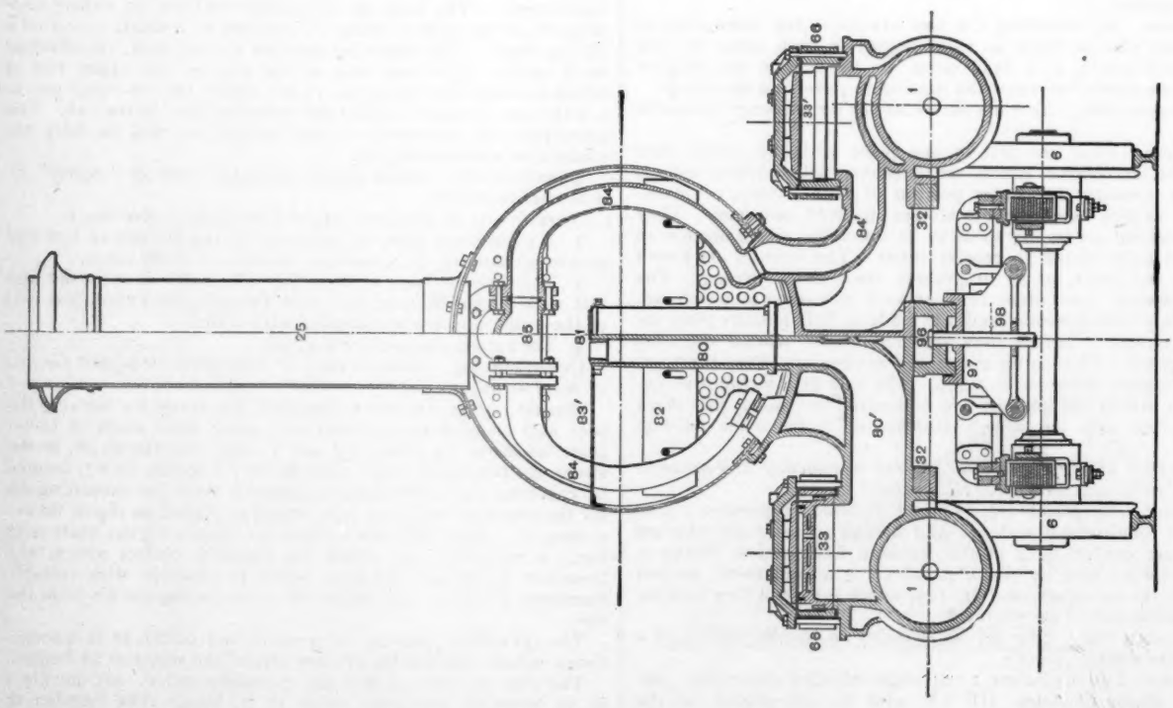


Fig. 164.

PASSENGER LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

thus expose it to a large radiating surface through which the heat is conducted to the water.

The chimney or smoke-stack serves partly for removing into the open air the smoke which passes through the flues, and partly for producing a strong draft of air, which is indispensably necessary for the rapid combustion of the fuel. Smoke-stacks are also often provided with arrangements for arresting the sparks and cinders which escape from the fire.

QUESTION 290. *What is a locomotive head-light, and what is it for?*

Answer. A *head-light* is a large lamp, 35, which is placed on the front end of a locomotive to light up the track in front of it and give warning of its approach.

QUESTION 291. *What is a cow-catcher, and what is it for?*

Answer. A *cow-catcher*, 38, as its name implies, is intended to "catch cows" or other obstructions on the track and throw them off, thus preventing them from getting under the wheels while the engine is running. It is a triangular-shaped structure made of wooden or iron bars and attached to the front of the engine.

QUESTION 292. *What is the sand-box on a locomotive for?*

Answer. The sand-box, 39, is usually placed on top of the boiler, and has pipes, 40, on each side of the engine by which sand is conducted to the rails in front of the driving-wheels, to prevent them from slipping when the engine is working hard.

QUESTION 293. *What is the cab of a locomotive for?*

Answer. A cab, 43, is for the protection of the men who run the engine from rain, cold, and sunshine.

QUESTION 294. *How is the locomotive connected to the train behind it?*

Answer. By an iron bar, 48, called a draw-bar, which is attached by a pin, 49, to a casting on the back end of the engine. The draw-bar is coupled to the tender behind the engine by another pin similar to the one on the engine. The engine and tender are also coupled together by chains, 50, called safety-chains. These are used as a safeguard to prevent the engine and tender from separating in case the draw-bar should break.

QUESTION 295. *How are the water and fuel carried which must be supplied to a locomotive while it is running?*

Answer. The water is carried in a tank, which is usually constructed in the form of a letter U, so as to give room for the stowage of fuel between its two branches or sides, and is carried on a set of wheels, which forms a separate vehicle, independent of the locomotive, called a *tender*, the construction of which will be explained in a future chapter. In another class of engines, called *tank-engines*, the water-tank and fuel are carried on the engine.

The following is a list of parts designated by the numbers on plates III, IV, V, and figs. 164 and 165:

1 Cylinders.
2 Main driving-axle.
3 Connecting-rod.
4 Coupling-rod.
5 Main crank-pin.
6 Truck wheels.
7 Main driving-wheels.
8 Back driving or trailing wheels.
9 Fire-box.
10 Expansion clamps.
11 Eccentrics.
12 Eccentric-rods.
13 Link.
14 Rocker.
15 Link-hanger.
16 Horizontal arm of lifting-shaft.
17 Lifting-shaft.
18 Upright arm of lifting-shaft.
19 Reversing-rod.
20, 21, 22 } Reversing-lever.
23 Cylinder, or waist of boiler.
24 Smoke-box.
25 Chimney or smoke-stack.
26 Water spaces.
27 Grate.
28 Furnace-door.
29 Ash-pan.
30 Front ash-pan damper.
31 Back ash-pan damper.
32 Frames.
33 Main-valve.
34 Valve-stem.
35 Head-light.
36 Head-light reflector.
37 Head-light lamp.
38 Cow-catcher.
39 Sand-box.
40 Sand-pipes.
41 Bell.
42 Dome.
43 Cab.
44 Safety-valve.
45 Safety-valve lever.
46 Whistle.
47 Whistle-lever.
48 Draw-bar.
49 Coupling-pin.
50 Safety-chains.
51 Throttle-lever.
52 Injector.
53 Injector steam-pipe.
54 Injector feed-pipe.
55 Injector check-valve.
56 Running-board.
57 Hand-rail.
58 Equalizing-lever.
59 Driving-springs.
60 Counter-balance weights.
61 Driving-wheel guard.
62 Guide-bar.
63 Cross-head.
64 Piston.
65 Piston-rod.
66 Steam-chest.
67,
68
69
70 Smoke-box door.
71 Cylinder-cocks.
72 Cylinder-cock lever.
73 Cylinder-cock shaft.
74 Truck-spring.
75 Truck-frame.
76 Truck equalizing-lever.
77 Truck wheel-guard.
78 Truck check-chain.
79 Push-bar.
80 Exhaust-pipes.
81 Exhaust-nozzle.
82 Deflector.
83 Wire-netting.
84 Steam-pipe.
85 T-pipe.
86 Dry-pipe.
87 Throttle-pipe.
88 Throttle-valve.
89 Throttle-stem.
90 Throttle bell-crank.
91 Steam-gauge.
92 Steam-gauge lamp.
93 Whistle lever.
94 Gauge-cocks.
95 Foot-board.
96 Truck center-bearing.
97 Truck center-plate.
98 Truck center-pin.
99 Whistle-shaft.
100 Suction-pipes.
101 Foot-steps of cab.
102 Hand-holds of cab.
103 Front door of cab.
104 Water-gauge.
105 Stand for oil-cans.
106 Drip for gauge-cocks.
107 Injector-valve.
108 Oil-cup for oiling main valves.
109 Handle for opening valves in sand-box.
110 Handle for opening front damper.
111 Bell-crank for opening front damper.
112 Rod for opening front damper.
113 Mud-plugs.

CHAPTER XII.

THE THROTTLE-VALVE AND STEAM-PIPES.

QUESTION 296. *How is the steam admitted to and the supply regulated or shut off from the cylinders?*

Answer. By a valve, *T*, fig. 90, called a *throttle-valve*, which is usually placed at the end of the pipe *O O' Q*, near the top of the dome. Throttle-valves are sometimes placed in the smoke-

box at the front end, *O*, of the dry-pipe. Until within a few years they consisted of plain slide-valves which covered openings similar in form to the steam-ports, but smaller in size. The pressure on such valves is of course greatest when there is no steam underneath, which is the case when the valves are closed. It is then very difficult to open them, and as it is important that the supply of steam admitted to the cylinders when the locomotive is started should be easily regulated, such valves are objectionable, and therefore the form has been introduced which is illustrated in fig. 90, and also on a larger scale in figs. 166 and 167, which represents a longitudinal section and plan of the throttle-pipe valve and throttle lever. The valve *T* is what is called a *double-poppet valve*, and consists of two circular disks, *a* and *b*, which cover two corresponding openings in the end of the pipe *Q*. When these disks are raised up, as shown in fig. 166, steam flows in around their edges, as represented by the darts. It will be observed that the steam pressure in the boiler comes on top of the disk *a* and against the under side of *b*. The pressure on the one thus neutralizes or balances that on the other. If the two disks were of the same size, the pressure of the one would be exactly the same as on the other; but as they are joined together and are made to fit steam-tight on their seats by *beveled joints*, their diameters must be somewhat larger than the openings they cover. The only practicable way, therefore, by which the lower disk *b* can be introduced into the upper end of the pipe *Q* so as to cover the lower opening is through the upper opening *a*. For this reason the lower disk must be made

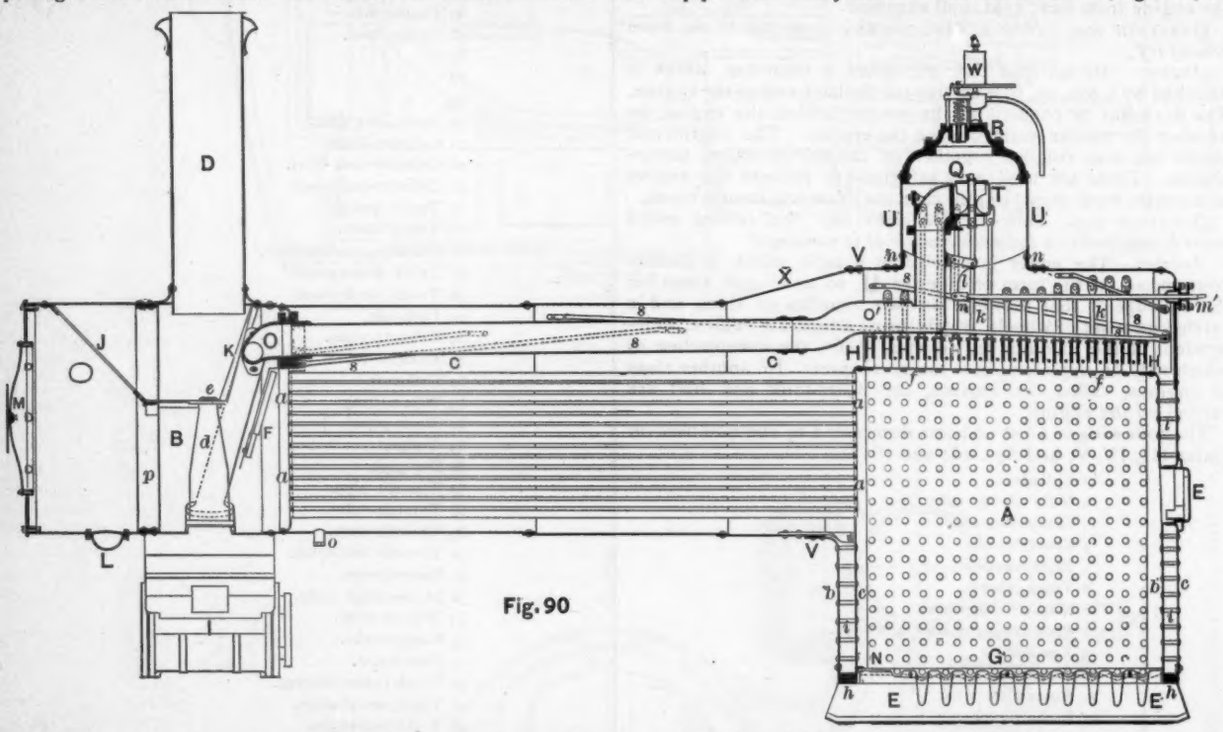


Fig. 90

smaller than the upper one, and therefore the pressure on the upper one, being in proportion to its size, it is in excess of that on the lower one and has a constant tendency to close the valve. As it is of the greatest importance that a throttle-valve should remain closed after steam is shut off, and never be opened at any time accidentally, the arrangement described accomplishes just what is needed—that is, makes the valve work comparatively easily, and at the same time keeps it closed after the steam has been shut off.

QUESTION 297. *How is the valve opened and closed?*

Answer. By a lever, *A B C*, called a *throttle-lever*, figs. 166 and 167.* This lever is connected by a rod, *d B*, called the *throttle-stem*, with the lower arm of the bell crank, *d c e*, the other arm of which is connected by the rod *e f* with the throttle-valve *T*. The rod *d B* works through a steam-tight stuffing-box, *E*, in the back end of the boiler. The end of the throttle-lever is attached to a link, *D C*, fig. 167, which is fastened by a pin to the stud *D*. This link has a slight vibratory motion, which enables the pin *B*, by which the lever *A B C* is fastened to the rod *d B*, to move in a straight line, which is necessary in order that the rod may work steam-tight in the stuffing-box, *E*. The throttle-lever has a latch, *l*, which gears into a curved rack, *n m*, so as to hold the lever and valve in any required position. This latch is operated by a trigger, *k*, which is connected to the latch by a rod, *r*. Various other devices are used to fasten throttle-levers and thus hold them in any position required.

QUESTION 298. *How are the steam-pipes constructed?*

Answer. The steam, after it is admitted by the throttle-valve, as was explained in answer to Question 296, passes into the throttle-pipe *Q* and the dry-pipe *O' O*, fig. 90. At the front end of the dry-pipe a pipe, *O*, which divides into two branches like the top of the letter T, and is therefore called a T-pipe, is attached. This pipe is indicated by number 85 in fig. 164. The steam-pipes 84, 84, fig. 164, are connected to each of the two branches of the T-pipe at one end and to the cylinders at the other.*

These pipes, being in the smoke-box, are exposed to great changes of temperature, and are therefore subjected to expansion by heat and contraction by cold. The joints are therefore constantly liable to disturbance by the contraction and expansion of the pipes, and so are difficult to keep tight. It is also practically impossible to construct the boiler, the cylinders and the pipes with perfect accuracy, and therefore a small amount of adjustability and flexibility is necessary in the joints of the pipes. If, for example, the upper end of the pipe 84′ in the cylinder, fig. 164, were either too near or too far from the center of the engine, it would be necessary to move the end of the pipe 84 either to the right or to the left in order to connect it with 84′. If the joint of the upper end of the steam-pipe were attached to the T-pipe with a flat joint like that shown at *a b*, fig. 168, it would be impossible to move the lower end of the steam-pipe either to the right or to the left without disturbing the joint and causing it to leak. For this reason these pipes are connected with what are called *ball-joints*, fig. 169—that is, the end *a b* of

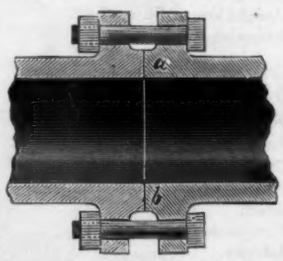


Fig. 168.

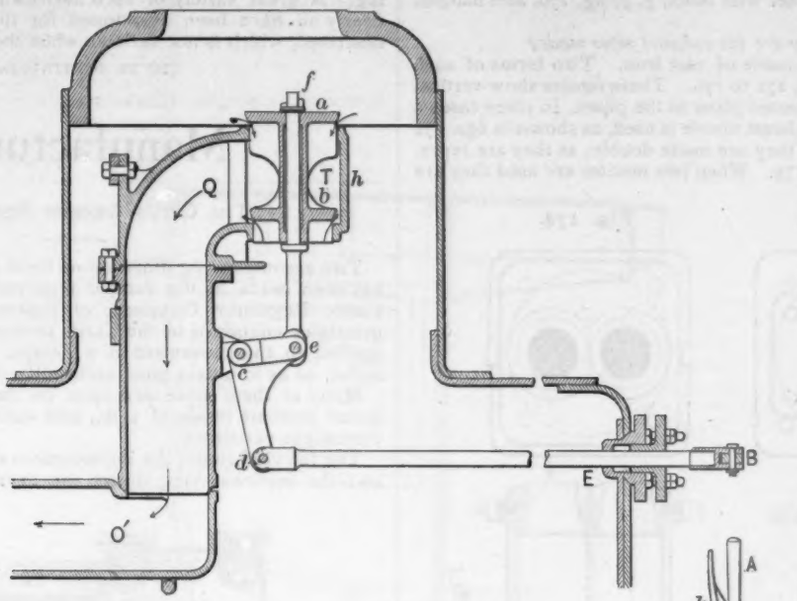
one of the pipes is turned into the form of a part of a sphere,† and the end of the other one into a corresponding concave form. It is known that a sphere will fit into a spherical socket in any position; for example, an acorn in its cup or the bones at the

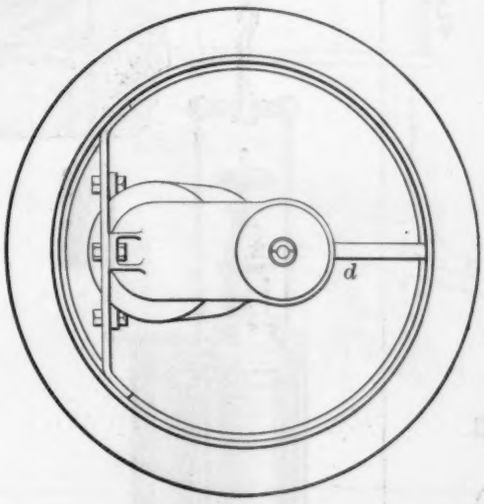
* Fig. 167 is a plan of the valve and lever.

* In fig 164 the right-hand side represents a section through the steam-pipe 84, 84′, and the left a section through the exhaust pipe 80′.

† The dotted lines indicate what would be the form of the sphere if the pipe was solid instead of hollow.

Fig. 166.





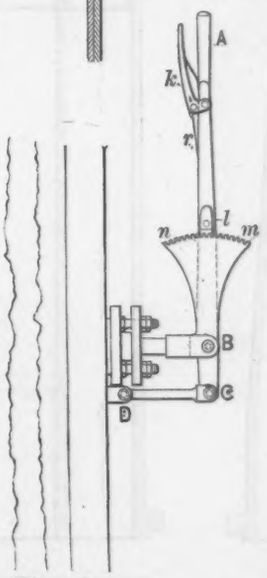


Fig. 167.

hip or shoulder joints. If, therefore, the pipes are joined with such spherical or *ball-joints*, as they are called, the lower end can be moved sideways several inches either way, and the joint will still be steam tight if it is then firmly bolted together. Even after it is bolted together it will have so much flexibility

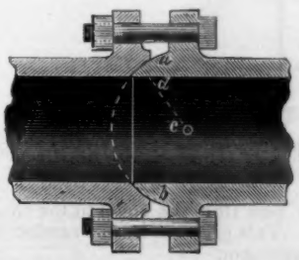


Fig. 169.

that the expansion and contraction of the pipes will not cause it to leak.

There is, however, still another difficulty. Although the lower end of the pipe, 84, fig. 164, can, with a ball-joint above, be moved in any direction horizontally, yet if the pipe is too long or too short it is obvious such a joint will not permit it to be moved up or down. A joint with a flat surface, like that shown in fig. 168, would, however, permit such motion in the pipe without leaking. If, for example, the steam-pipe were $\frac{1}{4}$ in. too short, it might be drawn down that distance, and if the upper joint were then screwed up it would still be steam-tight. In order, then, to get both vertical and lateral flexibility in the joints of the steam-pipes, a ring, *a b*, fig. 170, is interposed between the pipes. One side of this ring is spherical and the other flat, so that the pipes can move either around the spherical part or slip up or down or sideways on the flat surface of the ring. In this way the pipes are flexible and adjustable in every

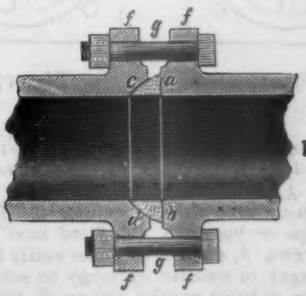


Fig 170.

direction, and for all kinds of motion caused by expansion, or which may be needed when the parts are put together. Sometimes the joints at one end only of the steam-pipes are made in this way, and the other is connected with a simple ball-joint.

In designing these joints their form should be drawn with a radius, *c d*, fig. 169, from one center, *c*, so that the surface of the joint will form a part of a sphere. If they are drawn from two centers, as is sometimes done, it is obvious that the surface of the joint will not be a part of a sphere, and therefore will not have the requisite flexibility. The surfaces of the joints are

carefully turned to the proper form, and then made steam-tight by scraping or grinding them with emery and oil, and the pipes are then fastened together with bolts, *g*, *g*, fig. 170, and flanges, *f f*, cast on the pipes.

QUESTION 299. *How are the exhaust pipes made?*

Answer. They are made of cast iron. Two forms of such pipes are shown by figs. 171 to 176. These figures show vertical sections, plans, and inverted plans of the pipes. In some cases a single blast orifice or exhaust nozzle is used, as shown in figs. 171 and 172, and in others they are made double, as they are represented in figs. 174 and 175. When two nozzles are used they are

Fig. 171.

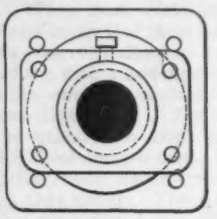
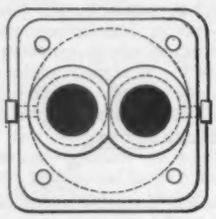


Fig. 174.



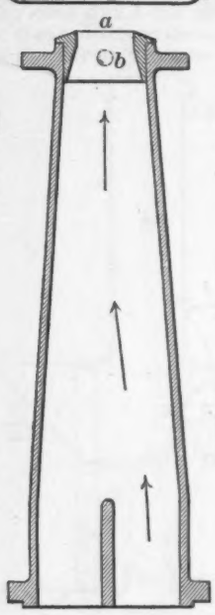


Fig. 172.

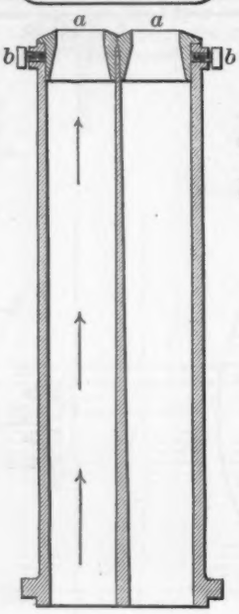


Fig. 175.

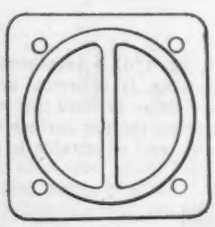


Fig. 173.

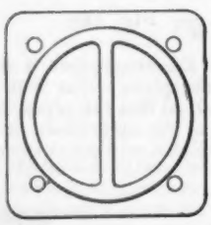


Fig. 176.

generally cast together, as shown in figs. 174–176. When only one is used, the form of the pipes resembles somewhat that of an inverted letter Λ, as shown in fig. 172, so as to cover the two openings which connect with the cylinders. The tops of these pipes have rings or bushings, *a a*, fitted into them, which are held by set screws, *b*, so that they can easily be removed and others with larger or smaller openings be substituted. If the openings in the exhaust-nozzles are small, the steam must be discharged at a higher rate of speed, in order to exhaust that which is in the cylinders, than if the blast orifices are larger. Therefore, if the latter are reduced in size, the draft becomes more violent, but at the same time the *back-pressure* in the cylinder (which will be explained hereafter) is increased. It therefore becomes necessary to adjust the size of the blast orifices with the greatest care, so as to have them just small enough to produce the required draft and yet leave them as large as possible, so as to reduce the back-pressure. For these reasons what are called *variable exhausts* are sometimes used. In these the blast orifice can be increased or diminished at pleasure, and thus regulated to suit the conditions under which an engine is working. A great variety of such devices has been used, but now nearly all have been abandoned for the simpler arrangement described, which is not variable when the engine is working.

(TO BE CONTINUED.)

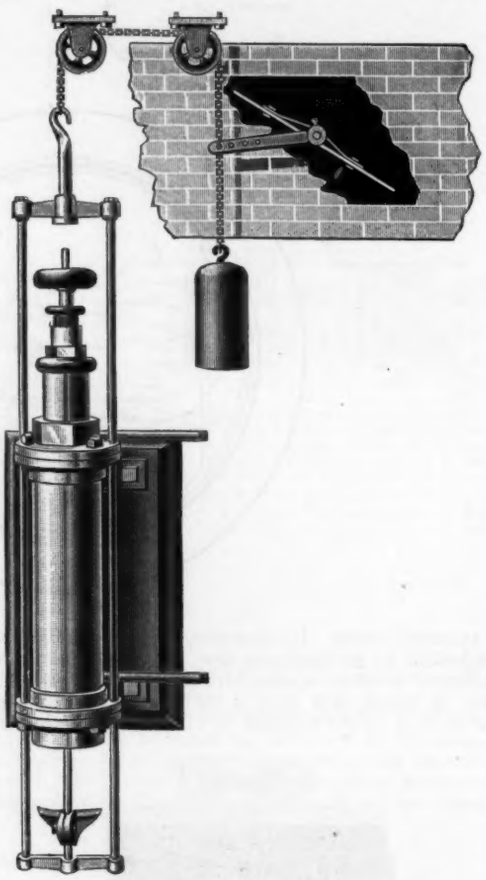
Manufactures.

The Curtis Damper Regulator.

THE accompanying illustrations show an improvement which has been made in the damper regulator manufactured by the Curtis Regulator Company, of Boston. In this device the principles contained in the Curtis pressure regulator have been applied to the movement of a damper in the flue of a steam boiler, so as to obtain great uniformity of boiler pressure.

Many of them close and open the damper with a change of boiler pressure inside of 1 lb., and maintain the pressure with very slight variations.

The full view shows the improvement as attached to a damper, and the sectional view shows the operating parts. Steam is



THE CURTIS DAMPER REGULATOR.

brought in a ¼-in. pipe from the boiler to the chamber surrounding the valve *E*. This pressure is also carried through the side pipe *A* to the diaphragm.

By turning down on the handle *H* the spring *S* is compressed, loading the diaphragm with any given weight, thus holding the valve *E* on its seat.

When the boiler pressure in the valve chamber rises high enough to lift this load the valve opens, say 0.01 in., admitting the steam on top of the piston *P*, pushing it down to the bottom of its stroke, overhauling the chain and closing the damper.

The latest improvement consists in extending the stem *D* of the follower (which rests on the phosphor-bronze diaphragm) up through the handle to such a length that the yoke rests on it when the damper is sufficiently closed, and forces the valve *E* to its seat, cutting off the flow of steam into the piston chamber.

PLATE IV.

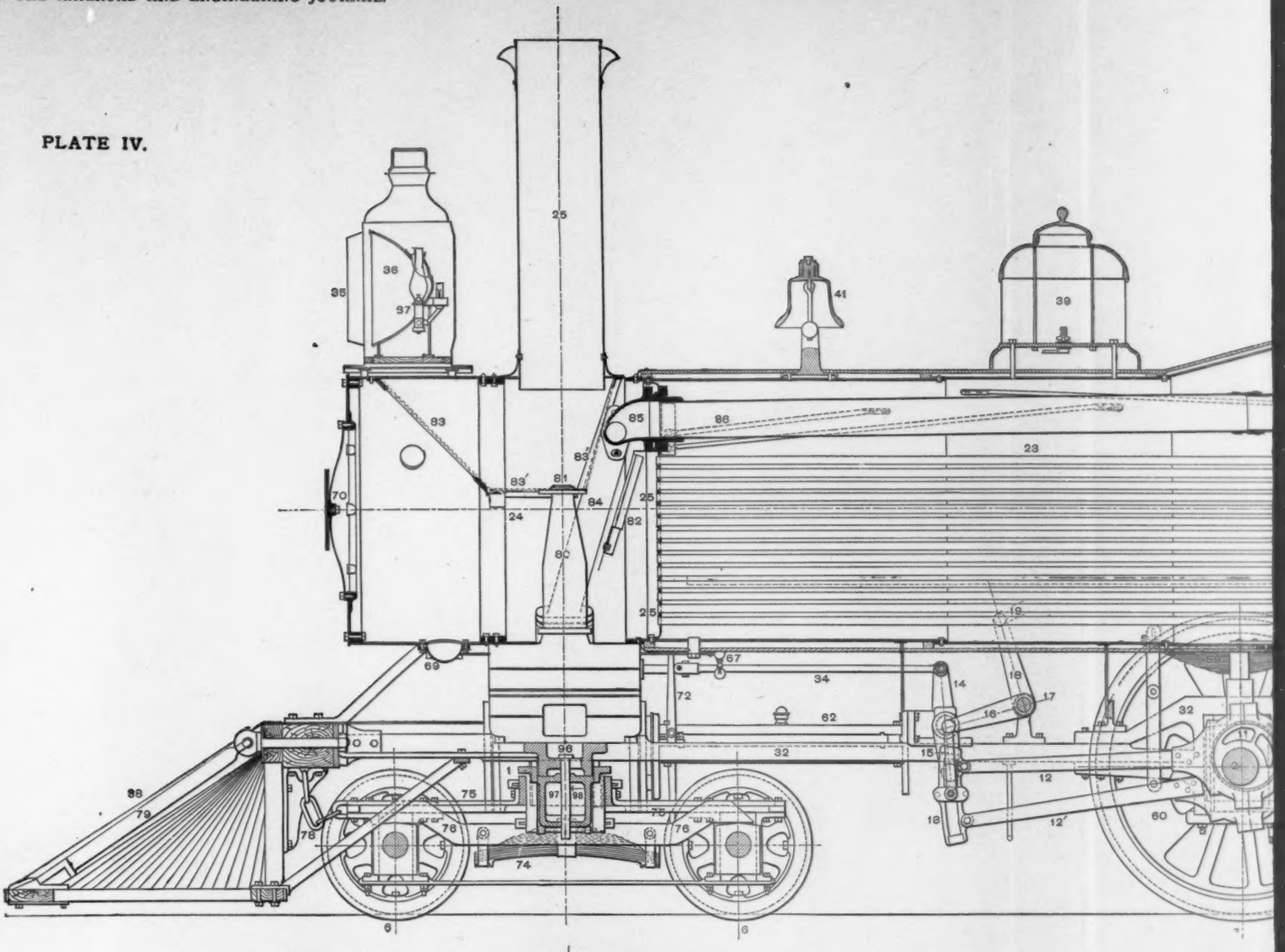
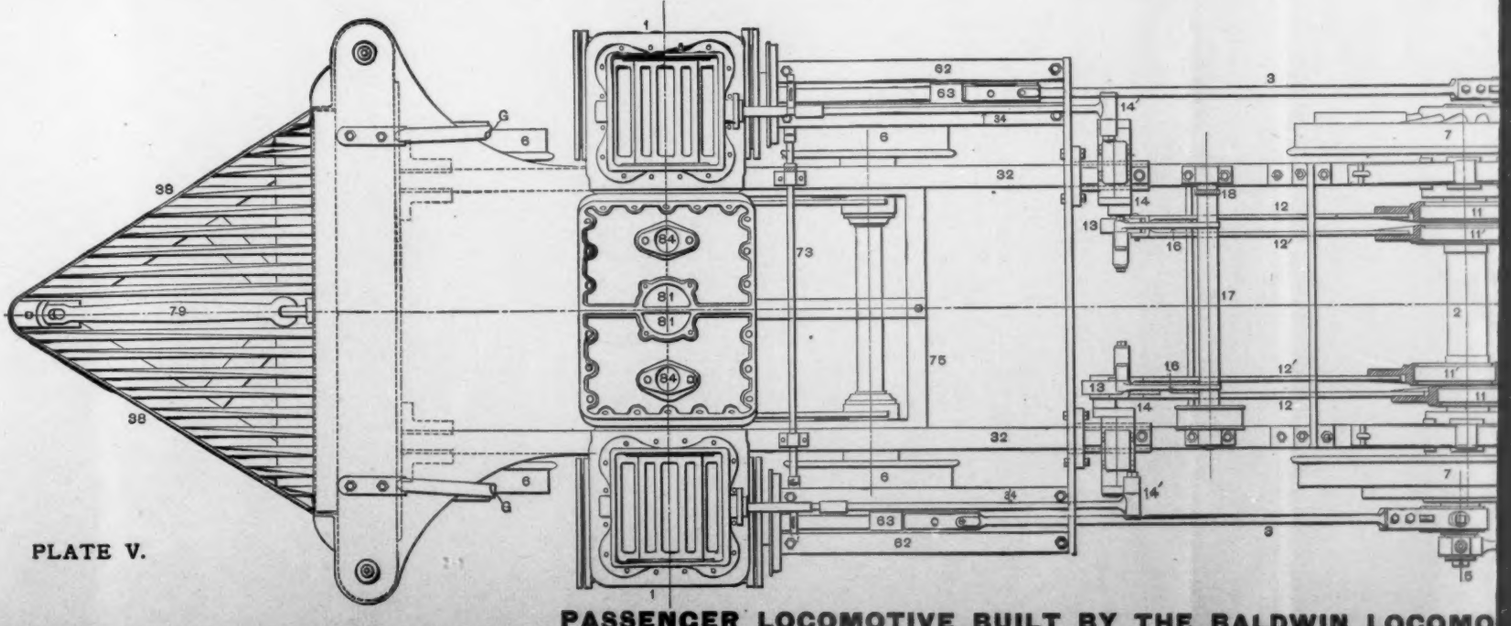
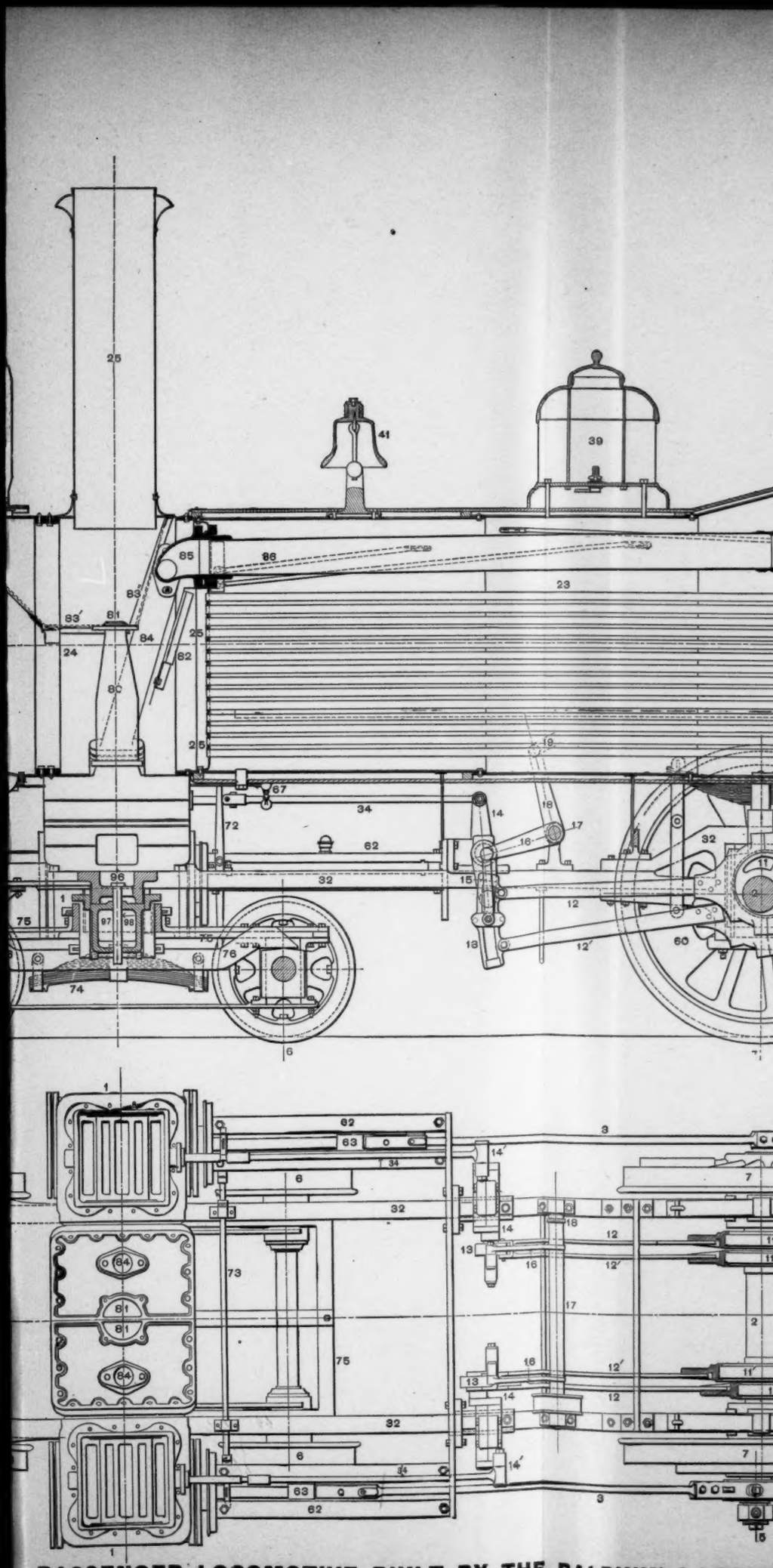


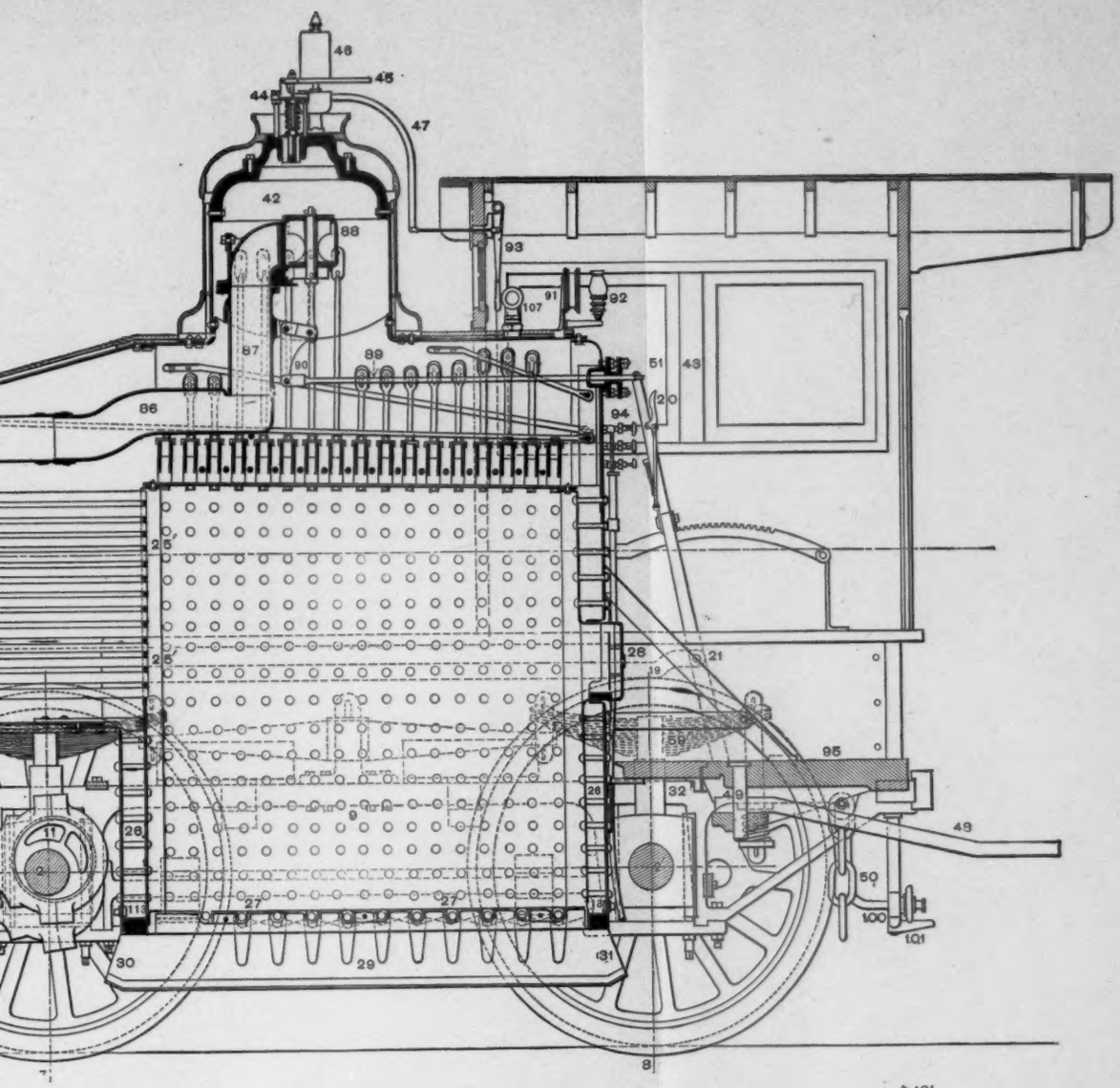
PLATE V.

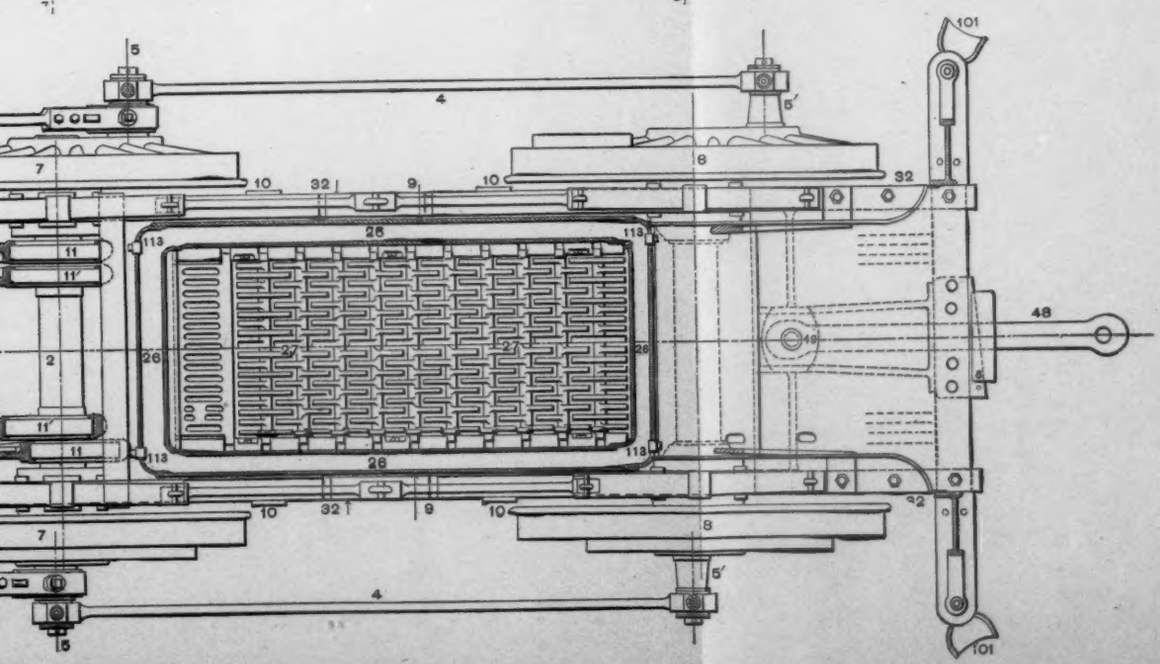


PASSENGER LOCOMOTIVE BUILT BY THE BALDWIN LOCOMO

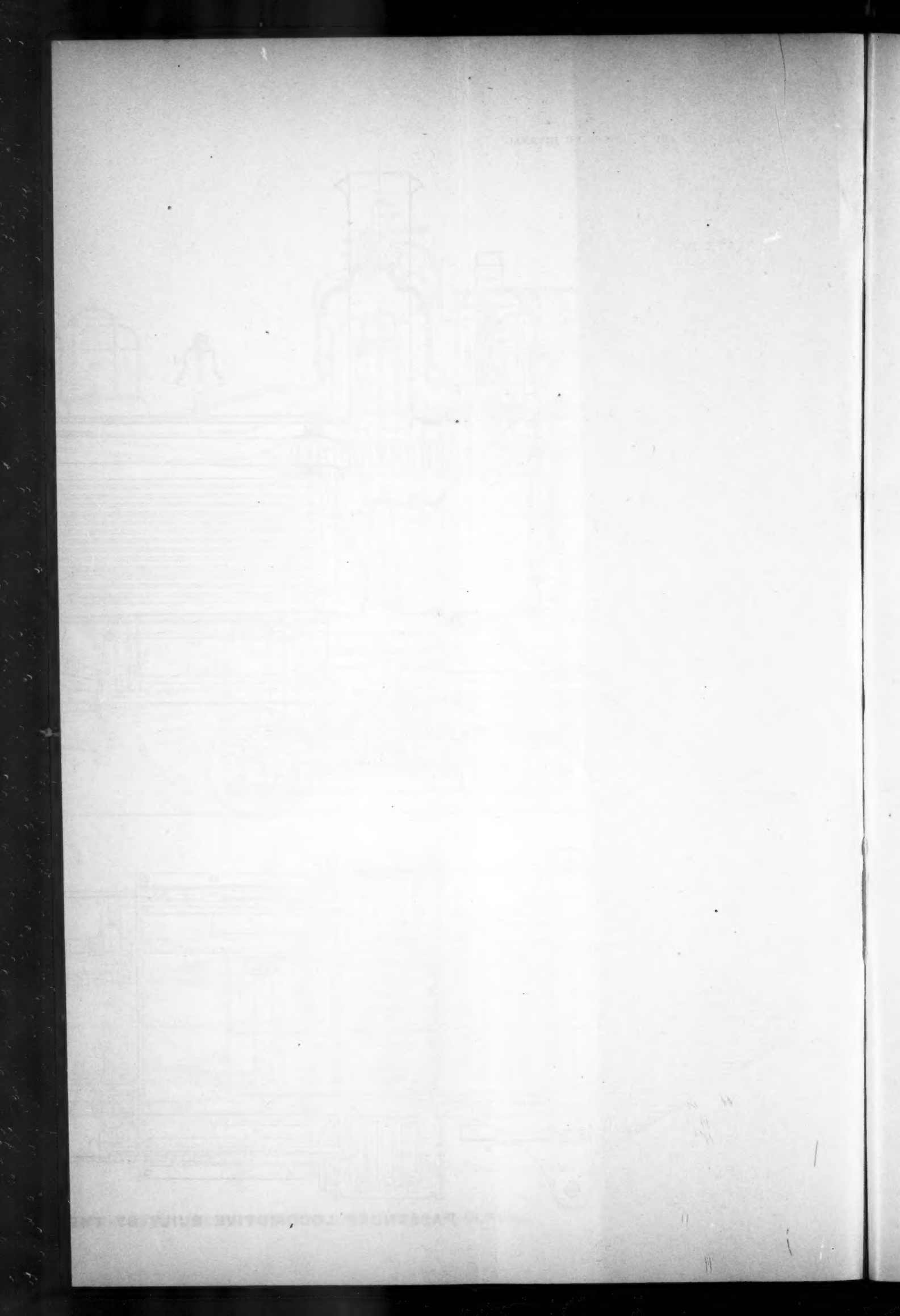


PASSENGER LOCOMOTIVE BUILT BY THE BALDWIN LOCOMO





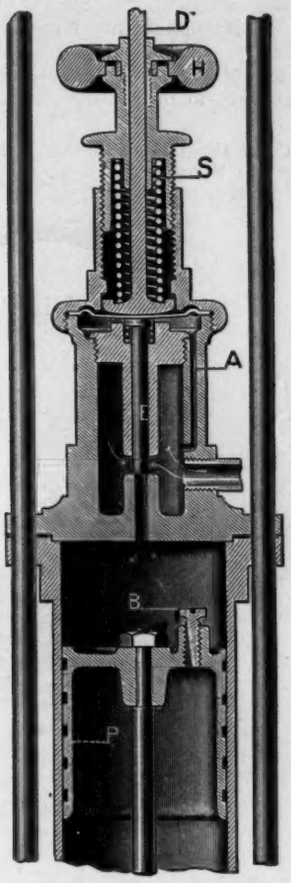
COMOTIVE WORKS, PHILADELPHIA.



The piston, starting back, relieves the pressure on the spindle *D*, permitting the valve *E* to open again, providing just the needful pressure in the cylinder to hold the damper closed until the boiler pressure falling, say ½ pound, has no longer power to open the valve, and the weight opens the damper.

The condensation in the chamber over the piston passing through the adjusting screw *B* is carried away by a small drip-pipe into the ash-pit.

Another improvement consists in making the piston *P* quite



long, a loose fit, and putting in water grooves, which make a tight water packing to a perfectly free piston which, from experience at work, has proved very effective.

The special object sought in this regulator has been to provide a device which shall be sensitive and at the same time proof against the rough usage and neglect which a boiler and its appendages sometimes, unfortunately, receive. In this, the steam being taken at full boiler pressure, there is sufficient power provided to move the regulator under any difficulties likely to arise in practice.

Marine Engineering.

THE Cleveland Shipbuilding Company in Cleveland, O., has completed a thorough reconstruction of its yard and plant, including a considerable extension of its shop facilities. The Company has on hand contracts to build five large triple-expansion engines, ten large Scotch boilers capable of carrying 150 lbs. of steam, and three steel steamers. One of these is a ferry-boat; the other two are freight boats for the Lackawanna Transportation Company. They will be 280 ft. long over all, 260 ft. keel, 38 ft. beam, and 25 ft. hold. The first one is nearly finished.

THE Harlan & Hollingsworth Company in Wilmington, Del., recently launched a new steamboat for the Maryland Steamboat Company. The new boat, which is intended for Chesapeake Bay service and is called the *Avalon*, is 190 ft. between perpendiculars, 200 ft. over all, 31 ft. breadth of beam, 10 ft. depth from base line to under side of deck at the lowest place. Her hull is of iron, double riveted, and has three bulkheads of iron, which will form water-tight compartments. The wheels are 22 ft. in diameter and have 12 buckets to each wheel. The boiler is cylindrical flue and return tubular, tested to 60 lbs. to the square inch, and is 18 ft. long and 11½ ft. in diameter. The steamboat is furnished with a vertical working beam engine 40 in. diameter and 10-ft. stroke, with Stevens adjustable cut-off and one donkey engine for fire. She will be furnished with Edison's electric lights, and will be provided with a search light on forward deck.

THE latest improvements in tank steamers built for the transportation of oil in bulk are the *Ocean* and *Chester*, just built by Russell & Co., of Glasgow, for Hermann Strusberg & Co., of New York. They are built of steel, 310 ft. long, and carry 3,500 tons of oil and 300 tons of coal. The boilers and machinery are entirely cut off from the oil tanks, which occupy 200 ft. of the vessels' length. There are 16 tanks which hold about 220 tons of oil each, and above the tanks and between the deck spaces are eight towers of 30 tons capacity each. These towers are for the purpose of keeping the tank full always, and thus secures the safety of the vessel, which might otherwise be endangered by the expansion and contraction of the oil. The 3,500 tons can be pumped out in 24 hours by the improved pumping facilities. The electric light is used, which is manufactured below decks to prevent the compass being affected by electricity.

THE Delaware River Shipbuilding Works at Chester, Pa., are building a new freight steamer for the Ocean Steamship Company, of Savannah. This vessel, which will be called the *City of Birmingham*, is expected to steam 11 knots with 2,300 tons cargo on board, besides coal enough for the round trip, on a draft of 16½ ft. of water. The principal dimensions are as follows: length, 320 ft. over all; breadth of beam, 42½ ft.; depth of hold, 26½ ft. The motive power will consist of a triple-expansion engine 24 in. high pressure, 38 in. intermediate, and 63 in. low pressure, cylinder with 45 in. stroke of piston. She will have piston valves on the high pressure, and slide valves on the low and intermediate cylinders. Four Sprang steel boilers will generate steam up to 160 lbs. pressure, and Montgomery's corrugated furnaces, made by the Continental Iron Works, of Greenpoint, L. I., will be supplied. Her decks will be three in number, with an additional deck running aft from the pilot house. She will have three large freight ports on each side. The officers' quarters and a large donkey boiler will be located on the spar-deck. She will be provided with steam steering gear and steam capstans, and will have electric lights.

Electric Haulage in Mills.

ABOUT four months ago an installation was made at the Tremont and Suffolk Mills, at Lowell, Mass., which has excited considerable interest among mill men in that section of the country. One of the difficulties to be met in this, as in other large mills, is the transporting and handling of cotton bales and heavy cases of cotton goods by the slow and expensive work of the ordinary day laborer. As the present buildings are located, all freight is received and delivered from one place. This necessitates some method of distributing the freight, such as cotton bales, etc., from this spot, and also the gathering of the manufactured goods from over the mills and the storing of the same at the freight house. In order to accomplish this work by the aid of electricity, plans were submitted by the Thomson-Houston Electric Company, and in a few weeks a motor was designed and placed upon the specially constructed car of the superintendent. For the last three or four months this motor has been running, giving perfect satisfaction.

The total distance of the road is 800 ft., running from one building across a bridge into another building and the entire length of the latter. This line is not a level one throughout, since the passage from one building to another introduces a grade of 3 to 3½ per cent. The system used is the single-wire overhead method, the rails answering for the return. The motor has a capacity of about four tons, and the gauge of the track is 4 ft. 8½ in. The controlling arrangements consist simply of a reversing switch, a speed regulator and a brake handle, which have acted without failure through very trying work. From the day of its starting no trouble whatever has been experienced, and the mill owners are perfectly satisfied with its operation, and we believe that they contemplate a considerable extension to this line, as they find that it is one of the most convenient mechanical arrangements which they have about their whole mill.

A prominent mill engineer who got on the car recently and took several rides and examined its operation very closely said that this system of collecting goods and carrying them to focal points is destined to a very general adoption.

If our readers are familiar with these large mills and the great floors several hundred feet long, they will readily see that a

narrow-gauge track, running the entire length of the room upon the floor, can be laid, and a small platform motor used to gather the cloth as it is taken from the machines. The success of this installation has brought about a number of important arrangements, and we understand that the company, realizing its great importance, are preparing for a very extensive line of work in this direction.—*Electrical World.*

The Keystone Seal Lock.

It would be a surprise to most persons to find how much ingenuity has been exercised in devising car seals of different kinds. They have been made in an endless variety of forms, with all kinds of ingenious devices to prevent their being tampered with, and to preserve their integrity and that of the contents of the receptacle which they are intended to guard. One of the defects, characteristic of many of them, is that they are not strong enough. They are made of flimsy wire or other attachments which would not stand hard service. Consequently

Fig. 1.

Fig. 2.

Fig. 3.

new seals have been devised and offered to the public, with a view to overcoming the objections inherent in the old patterns.

The engravings herewith, figs. 1, 2, and 3, represent one of these new forms which has recently been brought out. It has the merit of being strong and simple, and practically serves as a lock as well as a seal. It consists of a strong bail of steel wire bent into the shape shown in fig. 1, in which the seal is represented as detached from the wire. In fig. 2 the seal is shown in section in its relation to the wire before it is compressed, and fig. 3 shows it after being compressed in the wire. An ingenious press is furnished for these seals, which has a lever and eccentric for squeezing the seals between dies so as to fit the wire and receive the letters or other devices cut on the dies. The seals are made of a composition metal considerably stronger than lead, and which requires more pressure to make it "flow" than a softer metal would. For this reason a very powerful press is required, which the manufacturers furnish with the seals. It is made with a cavity into which the seals fit accurately, so that every one is an exact duplicate of every other, just as coins are duplicates, so that any deviations of the seals from each other are readily detected by ordinary inspection. For further information the manufacturer, A. B. Schofield, may be addressed at 170 Broadway, New York.

Splice-Bars.

Messrs. Morris Sellers & Co. during the past year have doubled the capacity of the Chicago Splice-Bar Mill, in which they manufacture the celebrated "Samson" bar.

The place where the fracture occurs in 99 out of 100 breakages of splice-bars or fish-plates is in the middle, where the two rails join. It is only a common-sense deduction from this fact that the bars should be made strongest at that point. In the Samson bar this deduction has been put into practice by making the bars thicker in the middle than at the ends, which means that the metal is put "where it will do the most good." These bars are at least a half inch thicker in the middle than ordinary bars, and, owing to the way in which the metal is distributed, they cost no more than ordinary bars.

The firm referred to has issued a circular giving a list of over 150 railroads on which more than 8,000,000 of these bars are now in use. In one instance it is reported from a road having 4,000 miles of track, half of which was laid with Samson bars, that only 1 per cent. of the breakages of splice-bars were of that pattern.

Manufacturing Notes.

The Indianapolis Hydraulic Jack Company recently furnished a number of its jacks to the Chicago, St. Louis & Pittsburgh Railroad.

The Miller Forge Company, Limited, in Pittsburgh is making an iron shaft 34 ft. long and 16 in. diameter for the towboat *W. W. O'Neill.*

The Swindell Construction Company in Pittsburgh has taken orders since January for a number of steel plants, furnaces, and gas producers for steel works.

The Brooks Locomotive Works in Dunkirk, N. Y., recently received orders for eight heavy mogul engines, seven passenger, and three switching engines for the Cleveland & Canton road.

The Baltimore & Ohio Railroad is building at its Mount Clare shops, Baltimore, a number of consolidation engines of increased power and weight, for service on the mountain grades. Total weight of engines in working order, 124,300 lbs.; cylinders, 20×26 in.; driving wheels, 50 in. diameter.

H. K. Porter & Co. in Pittsburgh lately shipped a small locomotive to the United States Government for improving the Columbia River in Oregon, and have now street motors under way for Tacoma, Milwaukee, St. Louis, and other places. These motors are enclosed to resemble street cars, and are smokeless and noiseless. The firm is also building a number of coke oven and furnace locomotives for Southern companies, and logging locomotives for Louisiana. One locomotive, just shipped to a copper company in Arizona, is for only 20 in. gauge of track, and with cylinders 9½ in. diameter. The firm also has locomotives and motors ready for shipment for the Croton Aqueduct, New York, Arkansas, California, Florida, and and Alabama.

The American Brake Company, of St. Louis, has recently placed its driver-brake on two of the Pennsylvania Company's "Class S" heavy freight locomotives, at the Fort Wayne shops. These brakes are now in regular service and give satisfaction. No special tests of their working have been made.

The City of Chicago has awarded a contract to Edward P. Allis & Co., of Milwaukee, Wis., for five new triple-expansion condensing pumping engines of the same design as the new West Side plant, recently built by that firm for the City of Milwaukee. These were the first engines of their type constructed in the country. The capacity of the Chicago engines will be 15,000,000 gallons of water per 24 hours each. The total cost of these pumping engines will be about $400,000.

THE Harlan & Hollingsworth Company in Wilmington, Del., has just delivered 15 sleeping cars, 5 parlor cars, and 5 day coaches to the Baltimore & Ohio; 4 day coaches and 4 eight-wheel cabooses to the Mexican Central; 5 day coaches to the San Francisco & North Pacific; 1 day coach and 1 baggage car to the Lackawanna & Pittsburgh. Among other work under construction in the shops are 7 sleeping cars (16 sections), 3 of them for the Boston & Albany, and 4 for the New York, New Haven & Hartford Railroad.

ORDERS have recently been received by Riehle Brothers, of the Philadelphia Scale & Testing Machine Works, for 1,000-lbs. cement testing machines for the City Engineer, Buffalo, N. Y.; Vanderbilt University, Nashville, Tenn., and others; also for a 2,000-lbs. cement testing machine for the United States Military Academy at West Point. Orders for larger testing machines include a 5,000-lbs. transverse testing machine for the Decatur (Ala.) Car Wheel Company; a 50,000-lbs. spring testing machine for the Atkinson Car Spring Company, Chicago; a 50,000-lbs. Vanderbilt machine for the Farrell Foundry & Machine Company, Ansonia, Conn.; and a screw-power Harvard testing machine of 100,000 lbs. capacity for the Baltimore & Ohio Railroad. Orders have also been received for pipe-testing machines, cloth-testers, and a number of heavy mine and rolling mill scales.

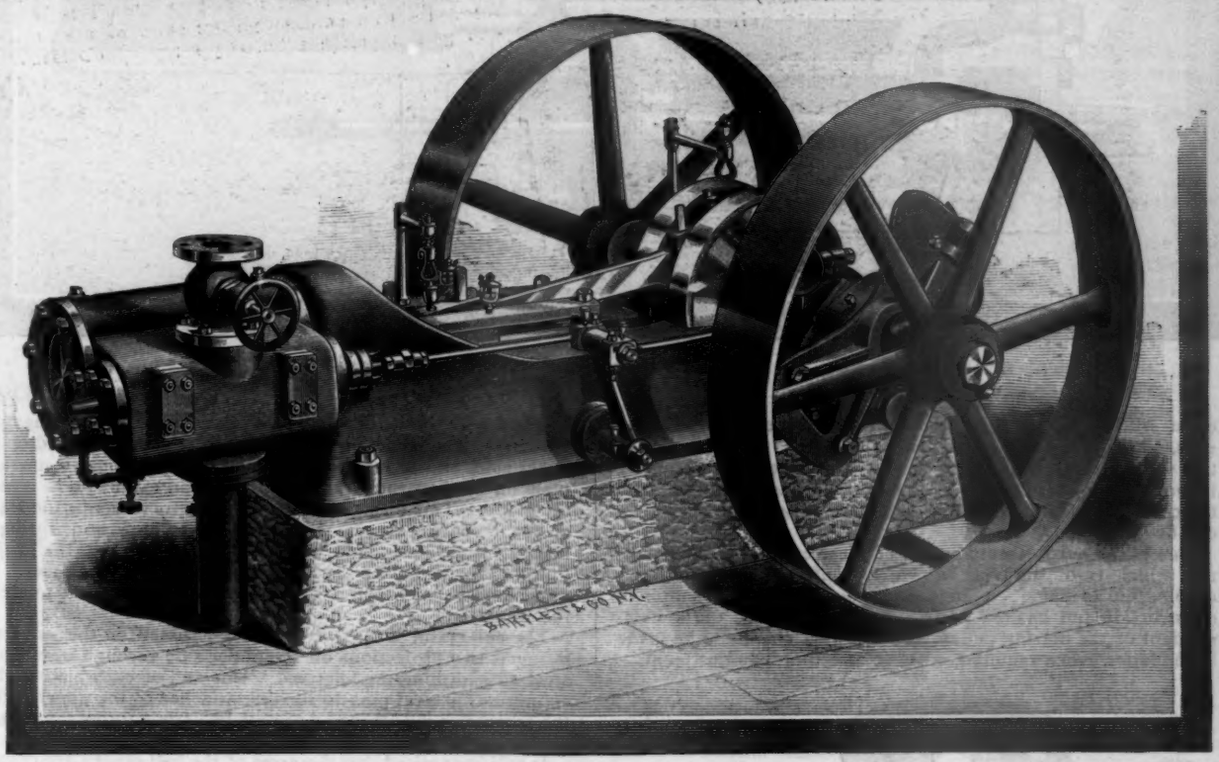


Fig. 1.

NEW AUTOMATIC CUT-OFF ENGINE.

Built by the Erie City Iron Works, Erie, Pa.

A New Automatic Cut-Off Engine.

THE accompanying illustrations represent a new automatic cut-off engine built by the Erie City Iron Works, at Erie, Pa. The object of the builders has been to produce an engine which will give close practical regulation, with changes either in load or in steam pressure, and at the same time shall be simple and without undue complication of parts. These engines are built from entirely new designs and patterns, and are so made that working parts can be duplicated and new parts furnished at any time. The cylinders are jacketed, the reciprocating parts well balanced, and care has been taken to make the work as durable as possible.

The engine bed is in form somewhat similar to the Porter type, and is so made as to bring the centers of the moving parts as low down as possible. The center of the cylinder is in line with the center of the crank-shaft. At the crank end the bed is made very wide, securing plenty of bearing for the foundation, giving abundant room for journals, and making the bed very strong.

The cylinder and steam chest are cast together and are shown in section in fig. 2, fig. 1 being a general view of the engine. The steam ports are very short, and the exhaust passage has an area fully equal to that of the exhaust-pipe; the arrangement is such that a quick exit is given to the exhaust steam. The steam ports are covered by plates giving easy access for inspection without removing the valves or steam chest covers. The valves are piston valves of a very simple pattern, being formed merely of a thin ring of proper width made by a special method, so that when it is in position in the steam chest it is a perfect fit. The ring being sprung takes up its wear and keeps tight. The ring being circular is balanced, and live steam is admitted only between the two inside shoulders of the valve, which, being of equal area, balance each other. A small hole is drilled in the port side of the ring permitting live steam to enter only when the valve is admitting steam to the cylinder. The object of this is to counteract the tendency of the valve to close up when it is uncovered by the steam port, as the live steam entering the small hole acts on the inside of the valve ring, pressing it outward. The port is an annular space around the valve opening into the cylinder, and, the valve seat being arranged so that when the valve is cutting off at about one-eighth stroke, it works over the seat at each stroke, there is no chance for forming shoulders. The valve stem is supported at both ends as shown.

The crank shafts of these engines are forged solid in the bell part, then slotted, and the pin turned up out of the solid metal. The crank pin is equal in diameter to the shaft. The counter balances are rigidly fastened to the crank and are of sufficient size. The connecting rods are of forged iron, and the adjusting keys are so arranged that the length of the rod can be maintained at all times; they are secured by steel set screws. The cross-head is of cast iron sufficiently heavy, and the cross-head pins are turned up by a special machine.

The piston packing is made with three sprung rings fitted and turned to give the best protection against leakage of steam. With the piston, as with all the working parts of these engines, the object has been to give large wearing surfaces wherever possible. The piston rod is of steel, and is shrunk on to the head and then riveted over. The connection between the piston rod and cross-head is made by a heavy forged steel key.

The valve stem is made of steel and is fitted outside the steam

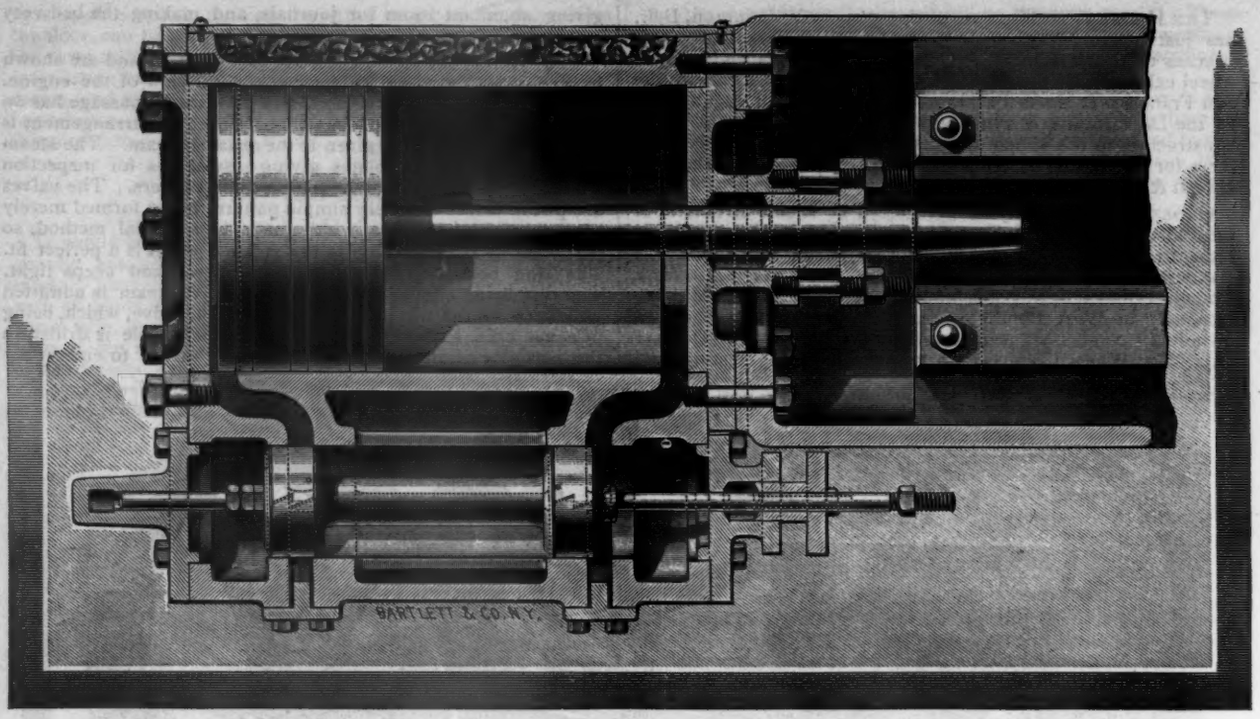


Fig. 2.

chest with a right-and-left-hand screwed connection and jam nuts, so that the valve can be easily adjusted. The practice in this shop is to test all engines and adjust the valves properly before they are sent out. The rocker has large bearings and the connections with the valve stem are so arranged that they can be adjusted.

One of the most essential parts of these engines is the governor, which is of the type known as shaft or isochronal governors, but is made on an entirely new plan; it is simple in construction and has few parts. As shown in fig. 3 it is independent of the driving pulley, and allows a change to be made in the latter, when required, without affecting its adjustment.

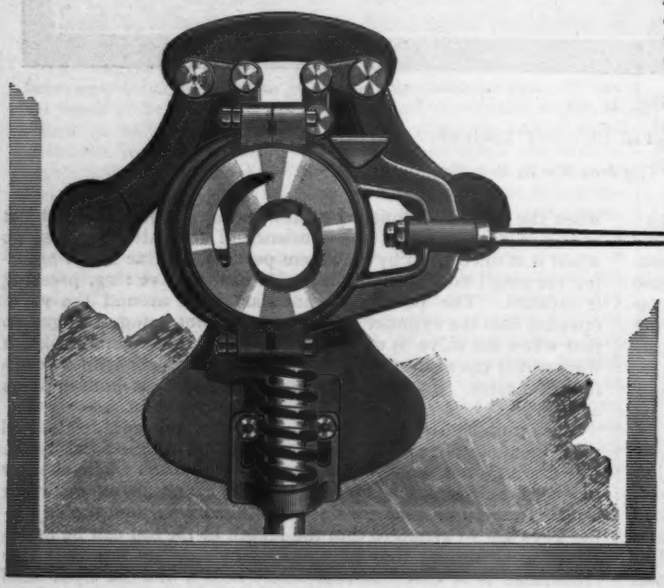


Fig. 3.

The main frame of the governor has a guide cast on the hub, next to the eccentric, to receive the corresponding slide which is cast on the latter. This slide is extended at the top and forms an arm to receive the links connecting the bell-crank levers to the eccentric. The latter has a slotted hole, through which the shaft passes, and permits the eccentric to be moved across the shaft in a straight line, altering the travel of the valve to correspond with the work required of the engine without changing the lead. The slide on the eccentric is also extended on the lower side, and forms a guide which passes through a movable plate on the governor frame, which has an extension to receive the guide. This forms a secondary guide for directing the travel of the eccentric across the shaft. A compression spring is placed around this guide, and has for its lower seat the projection on the movable plate through which the guide passes. Its upper seat is fixed, and is formed by a shoulder on the guide on the eccentric.

The bell-crank lever weights are fulcrumed on the governor frame at two projections on the upper side through which pass steel pins forming the fulcrums. One end of each bell-crank is connected by steel pins to the link attached to the upper end of the eccentric; the other end of each bell-crank forms the centrifugal weight.

It will be noticed that the arms of the bell-cranks are considerably out of the perpendicular; this gives the weights a certain amount of gravity, which is proportional to the gravity exerted by the eccentric when in the vertical position, as shown, and exactly balances the eccentric and parts. This effect is also entirely independent of the centrifugal force exerted by the weights, and, owing to the balancing of the parts, the engine is found to be very quiet when running.

The working of the governor may be described as follows: When the engine is idle the weights and eccentric have such a position that should the engine be turned over by hand, the valve would be at its greatest travel; as soon as steam is admitted, and the engine begins to revolve, the weights attain increased centrifugal force as the engine runs faster and faster, until the speed is such as to give enough force at the weights to overcome the resistance of the springs, when they fly out and alter the throw of the eccentric, and thus cut off the supply of steam to the amount required to perform the exact work and maintain the same speed. When the engine is required to develop more power by increased load, there is a slight retardation in speed, dependent upon the amount of increased load, which instantly decreases the centrifugal force and permits the spring to adjust the eccentric to the required travel of the valve to develop the proper power and maintain the correct speed. When the load is diminished the action is just reversed. The speed of the engine may be altered somewhat from that at which the engine is originally intended to run, by compressing the spring by means of the movable plate, if greater speed is required, and by reducing the compression by the same means if less speed is required. The limit of change in speed should not exceed 5 per cent.; when more is required a new spring must be used, and the weights should probably be changed also.

Figs. 4 and 5 show two indicator cards, the particulars of which are as follows :

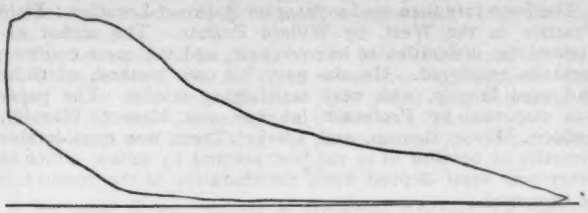


Figure 4 :

Size of cylinder.....	10 by 12 in.
Revolutions per minute.....	260
Scale.....	60
Mean effective pressure.....	25.1 lbs.
Indicated horse-power.....	31.00

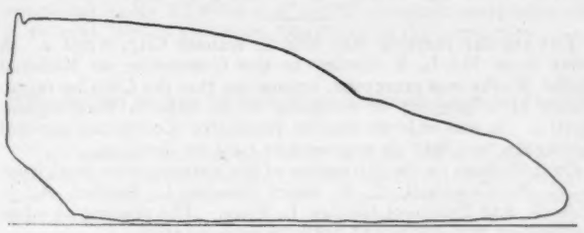


Figure 5 :

Size of cylinder	10 by 12 in.
Revolutions per minute.....	260
Scale.....	60
Mean effective pressure.....	44.8 lbs.
Indicated horse-power.	55.44

These cards were taken from an engine of the pattern described, to which steam was delivered through a pipe 250 ft. long.

Proceedings of Societies.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, March 21. The Secretary announced the death of Squire Whipple, and, after some remarks, it was ordered that a committee be appointed to prepare a memoir.

A circular communication on Increasing the Durability of Timber, from the Forestry Division of the U. S. Department of Agriculture, was read.

The Secretary read a paper by Edward Prince upon a 30-in. wooden conduit designed and constructed for the Quincy, Ill., Water-Works. The conduit connected the iron water-pipe on shore at the pumping-station with the point of supply at a crib 1,480 ft. away in the Mississippi River, and was built in three sections of 540, 548, and 400 ft., towed out to position, launched, then connected, ballasted, and sunk to position.

The Secretary was requested to ask Mr. Prince for further data than was embodied in the very brief description. It was thought that in some parts of the Mississippi the current would scour underneath the conduit and soon let it down many feet, effectually protecting it from navigation, ice, etc., and inquiry was made whether the increased length that would be required for the elongation of the conduit had been provided for.

Mr. Emil Kuichling presented a written discussion on Mr. McMath's paper on Sewers, which was further discussed by Mr. Hering.

A REGULAR meeting was held in New York, April 4. The Secretary announced the deaths of George W. Cass, Charles Latimer, and William A. G. Emonts, and committees to prepare memoirs were ordered.

Mr. J. F. Flagg presented a written discussion on the Flow of Sap in Trees, by J. F. Flagg.

Mr. R. K. Wright, Jr., lately Section Engineer on the Panama Canal, made some informal statements describing the condition and administration of the work ; replies were offered by Messrs. Appleton and Colné, and some discussion by members followed.

The Tellers announced the following elections :

Members : William Coulman Ambrose, San Francisco, Cal.; Francis Webster Blackford, Jr., Butte, Mont.; Howard Breen, Pittsburgh, Pa.; Edward Carlos Carter, Chicago, Ill.; John Joseph Donovan, Helena, Mont.; Frank Louis Fuller, Boston, Mass.; Bruce F. House, Denver, Col.; James MacFarlane, Anaconda, Mont.; Charles Clemons Rose, Scranton, Pa.; Horace Edward Stevens ; Charles Frederick Stowell, Albany, N. Y.; Arthur Newell Talbot, Champaign, Ill.; Charles Chancellor Wentworth, Roanoke, Va.

Associate : George Henry Crafts, Atlanta, Ga.

Juniors : William George Clark, Toledo, O.; Arthur Leland Cornell, Tarrytown, N. Y.; Edward Berton Kent, Milwaukee, Wis.; William Willis Penney, St. Louis, Mo.; Louis Lincoln Tribus, New York ; Harry R. Wheeler, Sing Sing, N. Y.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the House in Philadelphia, March 17, Vice-President John T. Boyd in the chair ; 30 members and 6 visitors present.

Mr. A. Marichal read a paper upon the Testing of Cements, calling the attention of the Club to the waste of money resulting from the incomplete knowledge of the properties of cements. "Some engineers spend many hundred dollars to test their cement ; yet the mortar used in their works is not worth a penny."

Mr. Marichal asked for the appointment of a committee of five who would recommend a *practical method of testing cements* and present it to the Club for its approval, which, on motion, was ordered.

The Secretary presented, for Mr. Frederic H. Robinson, a complete description of the Manufacture of Gunpowder.

Professor J. W. Redway followed with a discussion of the chemical reaction which takes place during the explosion of gunpowder and other explosives, giving a summary of results of experiments and investigations by himself and others.

Mr. L. F. Rondinella presented a paper upon Incandescent Electric Lighting, giving tables, formulæ, and calculations, for the determination of the relative commercial values of lamps of higher efficiency and shorter life, with those of lower efficiency and longer life.

AT the regular meeting of April 7, the Secretary presented, for Mr. Frederic H. Robinson, a description of the Electric Street Railroad, at Wilmington, Del.

Mr. William H. Robinson presented an illustrated paper upon Rope or Cable as a Transmitter of Power.

The Secretary presented, for Mr. C. A. Preston, a description of the Effect of Gases, etc., from Stacks, upon Iron, illustrated by a drawing of the Charles Street Bridge, over the Northern Central tracks at Union Station, Baltimore, Md., and by a very complete and interesting set of specimens of iron from the bridge.

Mr. Herbert Bamber presented notes upon Two Experiments with Cement Mortar.

Mr. Howard Murphy presented a diagram showing the results of Watertown Arsenal tests of the crushing strength of Potomac Red Sandstone and other building stones, bricks, and brick masonry.

Mr. Edward Hurst Brown mentioned that the reason the Potomac Red Sandstone was not more used for architectural purposes was that, while of a beautiful color, owing to its extreme hardness it was very difficult to dress, and also that very often in an apparently perfect stone a flaw would develop in dressing the face which would render it useless for facing stone.

A communication by Mr. G. Y. Wisner, C.E., for years connected with the Lake Survey, entitled Physical Phenomena of Lake Harbors, was submitted by title. It shows that the progressive movement of sandy spits is attributable to the resultant waves and currents produced by the periodic oscillations of the lake surface, and that the effects are similar to those produced by the flood-tide on the Atlantic Coast, as explained by Professor L. M. Haupt in his paper on the Physical Phenomena of Harbor Entrances.

Boston Society of Civil Engineers.

THE annual meeting was held March 21 in the parlors of Young's Hotel. After listening to the annual reports of the Governing Committee and the special committees, balloting was

had for election of officers for the coming year, with the following results:

President, D. Fitz Gerald; Vice-President, F. P. Stearns; Secretary, S. E. Tinkham; Treasurer, Henry Manley; Librarian, H. D. Woods.

After transacting some other business matters, the meeting adjourned to the large dining-hall to partake of the annual dinner.

Engineers' Society of Western Pennsylvania.

THE regular monthly meeting was held in Pittsburgh, March 20.

Mr. J. F. Bray opened the discussion on his paper on the Welding of Steel Tubes, which was read at the January meeting. The discussion was continued by Messrs. Barnes, Metcalf, and Koch, and Captain Hunt.

Professor F. C. Blake then read a paper on the Electrolytic Separation of Gold and Silver.

A REGULAR meeting was held in Pittsburgh, April 17, at which 56 members and 4 visitors were present. George H. Barbour and Louis B. Fulton were elected members.

A paper on Aluminum was read by Phineas Barnes. In the discussion on this paper A. E. Hunt, William Metcalf, T. P. Roberts, J. A. Brashear, and several other members joined.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, April 3. The following members were elected: Edward B. Meatyard, Geneva Lake, Wis.; Paul K. Richter, Daniel A. With, Chicago.

The Committee on Specifications for Highway Bridges was not ready to submit a formal report. The subject was, however, taken up and discussed at some length on the line of the last meeting.

The Committee on National Public Works reported the receipt from the Council of Engineering Societies of a copy of the Cullom bill for the establishment of a Bureau of Harbors and Water-ways, and memorial in its favor. The Committee reported resolutions in favor of the bill, which were adopted. The Committee also reported that an assessment or contributions for the work of the Council was desired.

Engineers' Club of St. Louis.

A REGULAR meeting was held in St. Louis, March 21. Messrs. William S. Henry and John B. Myers were elected members.

Mr. S. F. Burnet then read a paper on Cements and Mortar. He gave some practical hints on mixing and using same; also how specifications should read and tests be made. He exhibited specimens and gave results of tests. Some information on sand, water, and lime was given. The damaging effects of freezing were shown. Professor Johnson and Messrs. Bruner, Wheeler, and Russell took part in the discussion.

The Secretary then read a short paper by E. L. Corthell in review of one by Robert Moore on Interoceanic Ship Transfer, read before the Club March 2, 1887. The criticisms of Mr. Moore on the floating pontoon, the wheel load, comparative economy and capacity of carriage were reviewed to show the practicability of the design. Mr. Moore replied at some length.

Professor Johnson called attention to some bars of iron which had been broken in a testing machine after having been strained beyond their elastic limit and then allowed to rest. The results were: After a rest of one day, an increase of strength of 16 per cent. was shown; seven days, 22 per cent.; sixteen days, 26 per cent.

Mr. Bruner called attention to a remarkable case of filtering water through an ordinary brick wall. Professor Nipher reported the results of some experiments on leakage of gases through brick walls.

A REGULAR meeting was held in St. Louis, April 4. Mr. Russell Parker was elected a member. Resolutions in relation to the death of Frederick Schickle were reported and adopted.

The President presented a communication from L. E. Cooley, President of the Council of Engineering Societies on National Public Works, on the subject of the Reorganization of National Public Works. On motion it was made the special order for the next meeting, April 18.

The Secretary then read a paper on Railroad Location; Field Practice in the West, by Willard Beahan. The author explained the difficulties to be overcome, and the most common methods employed. He also gave his own method, which he had used largely, with very satisfactory results. The paper was discussed by Professor Johnson and Messrs. Wheeler, Seddon, Moore, Bouton, and Clark. There was considerable diversity of opinion as to the best method to follow, which in every case must depend upon the character of the country to be traversed.

Professor Nipher explained to the Club a calorimeter he had prepared for the purpose of determining the heat value of fuels. It was a quick method and gave accurate results. The apparatus was shown and a test made. After some general discussion of Western fuels, the meeting adjourned.

Engineers' Club of Kansas City.

THE regular meeting was held in Kansas City, April 2. A letter from Mr. L. E. Cooley to the Committee on National Public Works was presented, requesting that the Club be represented at a meeting of delegates to be held in Washington, April 9. It was ordered that the Executive Committee appoint a delegate, and that his expenses be paid by the Club.

Contributions to the discussion of the evening were read from C. E. H. Campbell, C. S. Burr, Charles L. Strobel, A. J. Tullock, and Professor George L. Vose. The reading of other discussions was postponed until the next meeting.

The following gentlemen were declared elected members: Charles C. Silman, Robert Gillham, Charles S. Brown, James H. Grove, E. J. Remillon, and Frank Allen. Associate Members: J. B. Hodgdon and George K. Musselman.

New England Railroad Club.

THE monthly meeting was held in Boston, April 11, President Lauder in the chair. The subject for discussion was Steam Heating of Passenger Cars.

Professor Lanza, of the Massachusetts Institute of Technology, opened the discussion. He said that there had been widely diverse opinions expressed regarding the heating of passenger trains by steam from the engine. Some say that sufficient steam can be taken from the engine without its loss being noticed, while others declare that the engine cannot make time if the steam for heating is taken from it. He stated that Mr. Lauder, of the Old Colony, had put the boat train of four cars at his disposal for the purpose of experiments, and that the experiments showed plainly that neither of the extreme statements is correct; neither is the loss of the amount of steam used inappreciable, nor is the engine unable to make time. In response to a question, he said that 40 lbs. pressure of steam was used in all the experiments.

The Gold system of heating was then explained by Mr. Gold and Mr. Bell, and Mr. Temple described the automatic arrangement for regulating the temperature of cars of the Johnson Electric Service Company, as tried on the Chicago, Milwaukee & St. Paul Railroad.

Mr. McElroy, Mr. Sewell, and Mr. Chase described their respective couplings for steam-pipes. Reducing valves and traps were last considered, and several were described.

New York Railroad Club.

THE regular monthly meeting was held in New York, April 19, with a large attendance of railroad men and others.

The subject of car heating was discussed at much length, the merits of different systems being set forth by their representatives.

Automatic Car Couplers had been announced as a second subject, but was postponed to the next meeting.

Western Railway Club.

THE regular monthly meeting was held in Chicago, March 21.

Mr. J. N. Barr read a paper advocating the use of six-wheel trucks for freight cars of 60,000 lbs. capacity. This, he believed, would be better than to increase the size of the axles.

The paper was discussed by Messrs. Verbryck, Smith, Sinclair, Rhodes, Hickey, Cooke, Schroyer, and Snow. Mr. Rhodes presented a number of facts based on experience in the Burlington brake tests.

The Secretary read a paper by Mr. John Mackenzie, on Wear of Locomotive Tires, in which a number of diagrams taken from worn tires were given. This paper was discussed by Messrs. Rhodes, Cooke, Smart, Gibbs, and Foster.

The subject of Car Axles was postponed to the next meeting.

A National Organization of Railroad Accounting Officers.

AT the recent meeting of railroad accountants held in Washington, a motion was unanimously adopted providing for the appointment of a committee of 15 to consider the desirability of forming a National Organization of Railway Accounting Officers similar to that of the officials of other departments of railroads. It was provided that this committee should be appointed by the Chairman of the Washington convention (Mr. Kirkman), who is also to be Chairman of the committee.

Association of North American Railroad Superintendents.

THE annual meeting was held in New York, April 9. Reports were received from the Committees on Roadway, on Frogs and on Transportation, and the usual miscellaneous business was transacted. On the following day the members took an excursion over the Lehigh Valley road to see the operation of the train-telegraph system.

The following officers were elected for the ensuing year: President, C. S. Gadsden, Charleston & Savannah; First Vice-President, L. W. Palmer, New York & New England; Second Vice-President, J. B. Morford, Michigan Central; Third Vice-President, T. W. Burrows, Indianapolis & St. Louis; Secretary, Waterman Stone, Providence, Warren & Bristol; Assistant Secretary, C. A. Hammond, Boston, Revere Beach & Lynn; Treasurer, R. M. Sully, Richmond & Petersburg; Executive Committee, C. W. Bradley, West Shore; W. F. Stark, Dayton & Union; R. G. Fleming, Savannah, Florida & Western; D. W. Sanborn, Boston & Maine, and the President.

General Time Convention.

THE spring meeting was held in New York, April 11. The summer schedules for through trains were adopted, and May 13 was fixed as the date when changes are to be made.

The Committee on the Transmission of Accurate Time was continued, and in this connection Commander Allen D. Brown, of the National Observatory at Washington, addressed the meeting on the manner in which the official time was sent out.

The report of the Committee on Car Mileage and Per Diem Rates was made, recommending the adoption of the mixed mileage and per diem system of charges for the use of cars. The report was laid over until the October meeting.

Officers for the ensuing year were elected as follows: President, H. S. Haines, Savannah, Florida & Western; First Vice-President, J. M. Toucey, New York Central & Hudson River; Second Vice-President, D. J. Chase, Atchison, Topeka & Santa Fé; Secretary, W. F. Allen, *Official Railway Guide*. Executive Committee, H. B. Stone, Chicago, Burlington & Quincy; J. W. Thomas, Nashville, Chattanooga & St. Louis; James McCrea, Pennsylvania; C. W. Bradley, West Shore; E. T. D. Myers, Richmond, Fredericksburg & Potomac, and John Adams, Fitchburg. The Convention adjourned to meet next October.

American Society of Mechanical Engineers.

MR. F. R. HUTTON, Secretary, has issued a circular announcing the seventeenth meeting, which will convene in the city of Nashville, Tenn., on Tuesday, May 8, at 8 P.M., and will adjourn on Friday of that same week.

The Headquarters and Secretary's office will be in the Maxwell House, corner of Church and Cherry streets, and as many as possible are urged to stay at the same house, for the sake of the advantages, social and professional, of this course.

The exact details of allotment of sessions, etc., will be given on the Docket, which will also give the order of presentation of papers, and which will be distributed in Headquarters as a condensed programme.

The Secretary calls attention to the rules for the presentation of papers, and requests all members to inform him whether they will attend the meeting. Special rates can be obtained on the railroads for members.

American Institute of Mining Engineers.

PROFESSOR R. W. RAYMOND, Secretary, has issued from his office, No. 13 Burling Slip, New York, a circular containing the following announcements:

1. The Fifty-first Meeting of the Institute will be held at Birmingham, Ala., beginning Tuesday evening, May 15, 1888. Communications concerning the meeting may be addressed to Mr. Kenneth Robertson, at that place. Further details concerning it will be issued in a subsequent circular.

2. No special railroad rates for members attending this meeting have been arranged. The number of members willing to accept the conditions now universally imposed on such arrangements (the immediate return without stops by the same route, etc.) has proved to be so small on former occasions as to give us no basis for negotiation with the railroad companies. The general facilities now offered by different lines in the way of tourists' tickets are not less favorable, and are more simple and elastic than anything which it is practicable to secure by special application.

3. It is expected that, after the sessions at Birmingham, the Institute will visit Anniston, Ala., and the interesting mines, furnaces, and shops in that vicinity. Since the accommodations for ladies at Birmingham are limited, it is suggested that ladies accompanying members should remain at the beautiful and commodious Anniston Inn during the Birmingham sessions.

4. Notices of papers to be presented at this meeting should be sent as early as possible to the Secretary, accompanied with either the papers themselves or full accounts of their character, length, illustrations, etc.

Master Car-Builders' Association.

THE following circulars have been issued by the Secretary from his office, No. 45 Broadway, New York:

BEST FORM OF DOOR HANGINGS, INCLUDING GRAIN DOORS.

The undersigned committee, appointed to consider the above subject and report at the Convention to be held in June, 1888, desire to obtain replies to the following questions:

1. What kind of side door and door hangings are you using on freight cars?

2. What grain doors are you using, and are you satisfied with the workings of same?

3. Are you using any patent doors and hangings, and what is your opinion of same?

4. What is your opinion of a flush door, and what kind have you used?

Please address replies to this circular to E. W. Grieves, Baltimore & Ohio Railroad, Mt. Clare, Baltimore, Md.

E. W. GRIEVES,
JOHN P. LEVAN,
JOHN VOORHEES.

STANDARD AXLE FOR CARS OF 60,000 LBS. CAPACITY.

Since the last Annual Convention of the Association, the form and dimensions of a proposed standard axle were submitted to letter ballot for adoption, and failed to receive two-thirds of the votes cast, which are required to adopt a standard. As the subject is an important one and is likely to come up for consideration again, it has been thought by the Executive Committee that it would be well to get the views of the members of the Association before the meeting of the next convention, in order to be prepared to take some action at that time, which would be acceptable to a majority of the members. You are, therefore, requested to fill out the dimensions which you would recommend for a standard axle for cars of 60,000 lbs. capacity, on the accompanying engraving, and return to the Secretary with your signature appended.

M. N. FORNEY, Secretary,
45 Broadway, New York.

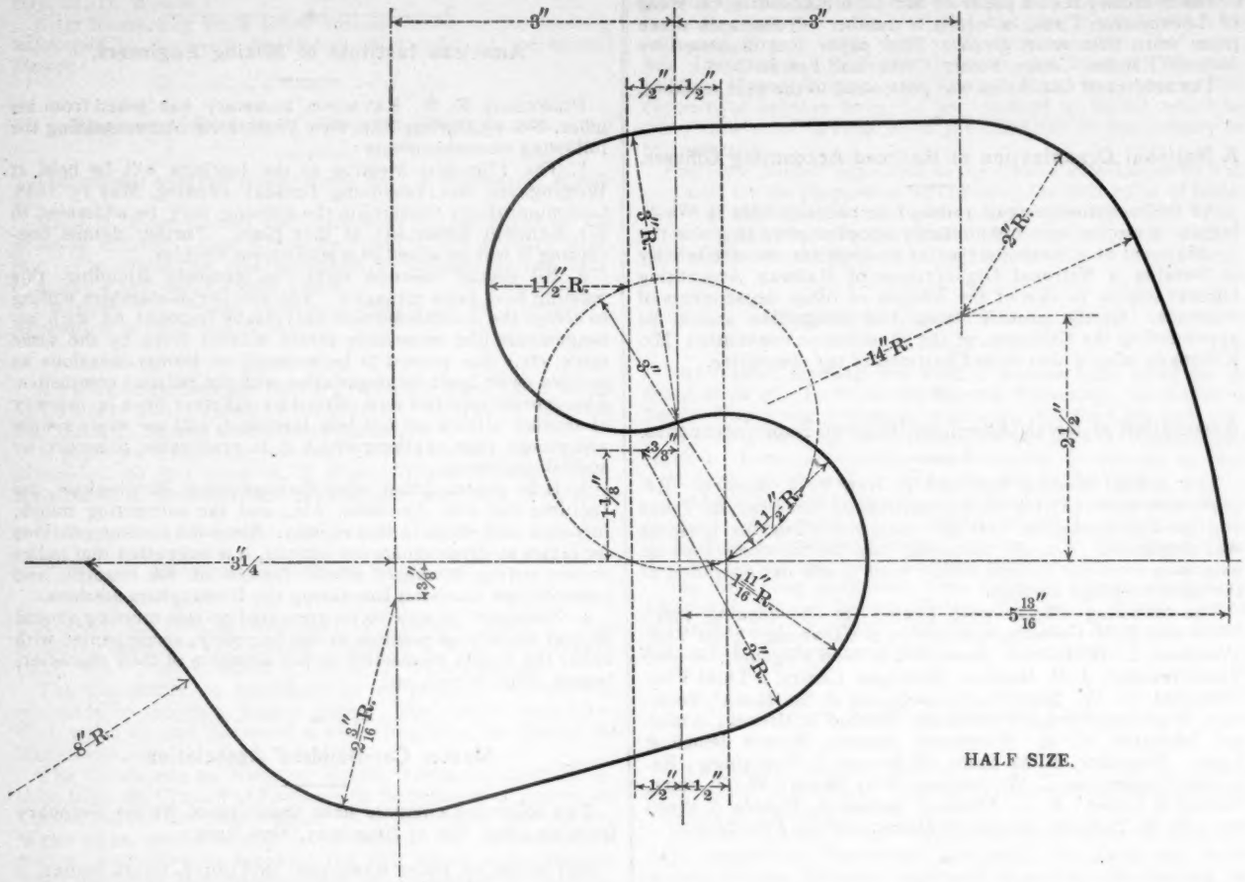
(A sketch of axle, with blanks left for the figures to be filled in, is appended to this circular.)

STANDARDS AND APPLIANCES FOR THE SAFETY OF TRAINMEN.

The Railroad Commissioners of the State of New York report that during the year ending September 30, 1887, there were 199

FORM OF CONTOUR LINES

for M. C. B. Automatic Car Couplers, as established by the Executive Commission of the Master Car-Builders' Association.



railroad employés killed and 896 more or less severely injured, in the performance of their duties. These accidents are classified as follows:

	Killed.	Injured.
Fell from train, engine, or cars, or getting on or off trains.	48	152
Striking low bridges, switches, tunnels, etc.	8	9
Coupling or uncoupling cars	30	437
Walking or being on track	102	88
Catching foot in frog or between rails	4	7
Derailment	1	19
Collisions	6	40
Other causes	10	144
Total	199	896

According to *Poor's Manual*, the number of locomotives owned by railroads in the State of New York in 1886 was 2,722, and in the whole country 26,415. It will be quite safe to say that there were ten times as many locomotives in the whole country as there were in New York State during the period covered by the Railroad Commissioners' report. If the average number of persons killed and injured per locomotive is the same elsewhere, the number of casualties to railroad employés in the whole country would be ten times the above figures, or a total in round numbers of 2,000 killed and 9,000 injured.

No pretence is made that this estimate gives the number of employés killed and injured with anything more than an approximation to accuracy. It must be remembered, though, that whatever errors there may be in the reports of accidents to the Railroad Commissioners, and of the number of locomotives in the country, are errors of omission, and that probably both the number of accidents and of locomotives are greater than reported, which would make the above estimate too low rather than too high. Nevertheless, with any reasonable deduction the record of frightful suffering, pain, and sorrow will be more than sufficient to emphasize the following inquiries, the aim of which is to elicit information that will indicate how the number of such accidents may be diminished.

All railroad officers and employés, whether members of the Master Car-Builders' Association or not, are therefore requested to answer the following questions:

1. What defects are there in the present construction of cars and locomotives which cause accidents to railroad employés by falling from trains, engines, or cars, or of accidents in getting on or off trains?
2. What changes could be made in cars or locomotives which would diminish the number of such accidents?
3. What kind of couplers and dead-blocks are the most dangerous to employés in coupling cars?
4. What kind of coupler and dead-blocks do you think is the least dangerous to employés?
5. Has the introduction of automatic couplers thus far lessened the danger of coupling cars?
6. Would the general introduction of automatic couplers in your opinion diminish the danger of coupling cars?
7. Can you suggest any way of lessening the number of accidents to employés from "walking or being on the track"?
8. How can employés be prevented from "catching their feet in frogs or between rails"?
9. In what way may any other kinds of accidents to employés be prevented or the number lessened?

All railroad officers and employés who see this circular are earnestly solicited to answer it, and thus add the weight of their testimony in helping to reduce the terrible sacrifice of life and limb which is annually exacted from our railroad employés.

JOHN KIRBY,
M. N. FORNEY, } Committee.

Replies to the above questions should be sent to M. N. Forney, 45 Broadway, New York.

ANNOUNCEMENT OF FORM OF CONTOUR LINES FOR M. C. B. STANDARD AUTOMATIC CAR-COUPLERS.

An engraving is sent herewith which shows the form of contour lines for the Master Car-Builders' standard type of car-coupler, which has been adopted by the Executive Committee to consummate the recommendation of the report made to and adopted by the Association at its last annual meeting, which was that "the Association procure one of the present makes of Janney Type of Coupler, selection being made by a committee appointed for that purpose, and that all other forms of couplers that will couple to and with this coupler, under all conditions of

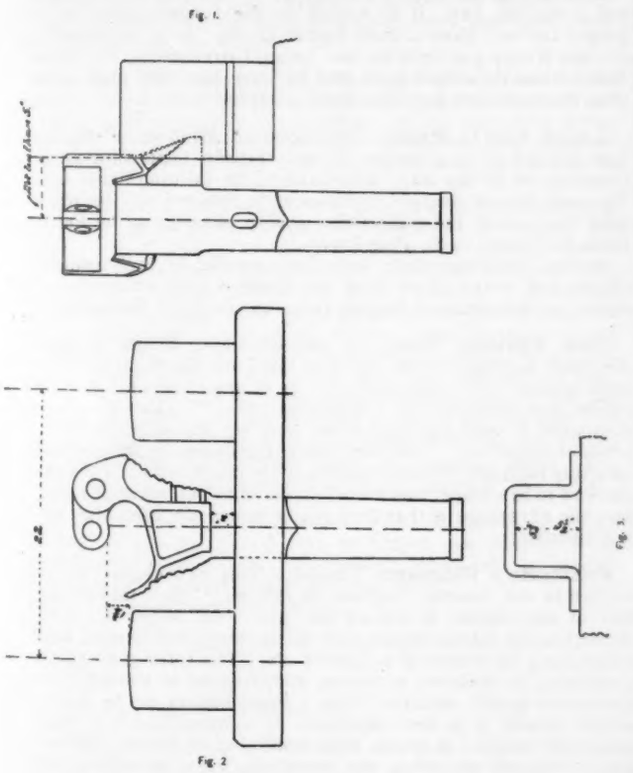
service, are to be considered as within the Janney Type and conforming to the standard of this Association."

The contour lines referred to and shown by the engraving were found to be described in Letters Patent No. 212,703, granted to Eli H. Janney, February 25, 1879, and to be covered by the 8th and 9th claims thereof.

The owners of said patent, in consideration of the adoption of the Janney type of coupler as the Master Car-Builders' standard type of freight car coupler, have agreed to waive their rights secured by said 8th and 9th claims, in favor of all railroad companies members of this Association and the Eastern and Western Railroad Associations which may decide to adopt the Master Car-Builders' type as their standard; and an agreement has been perfected whereby each railroad company may secure a license covering the right to make and use freight car-couplers containing said contour lines on making application therefor to William McConway, Vice-President of the Janney-Hien Coupler Company, Pittsburgh, Pa.

In making this concession, it will be understood that the owners of said patent do not thereby license or convey any right secured to them by the other claims of said patent or by any other patents owned or controlled by them.

In order to secure uniformity in the dimensions of the stem, dead-blocks and carrier irons and proper protection for the Master Car-Builders' type of coupler, the Executive Committee



recommend the dimensions given in the accompanying engravings (figs. 1, 2, 3, 4 and 5). The Committee are of the opinion that double dead-blocks or bumpers should invariably be used with this type of coupler. The contour lines are now the standards of the Association, and it is the purpose of the Executive Committee to submit its recommendations with reference to the dimensions of stem, etc., and the use of dead-blocks, for adoption as standards at the next convention of the Association.

By order of the Executive Committee.

M. N. FORNEY, Secretary.

Master Mechanics' Association.

THE following circulars have been issued by Mr. Angus Sinclair, Secretary, from his office, No. 175 Dearborn Street, Chicago:

REPLIES TO CIRCULARS OF INQUIRY.

Several chairmen of committees of investigation have complained that very few replies have been received to their inquiries. As reports have to be sent to the Secretary before the meeting of the Annual Convention, it is necessary that members should reply to the circulars immediately. Members are urged to attend to this matter at once.

For the Advisory Committee,

ANGUS SINCLAIR, *Secretary*.

TWENTY-FIRST ANNUAL CONVENTION.

This Convention will meet at Alexandria Bay, N. Y., at 9 A.M., on June 19. The headquarters of the Association will be in the Thousand Island House, and rooms for members and their families may be obtained there on application to Mr. R. H. Southgate. The terms are $3 per day.

Alexandria Bay is in the Thousand Islands region, on the New York side of the St. Lawrence, near the outlet of Lake Ontario, and 12 miles from Clayton, on the Rome, Watertown & Ogdensburg Railroad. Boats connect for Alexandria Bay with all trains arriving at Clayton. Connections are made at Suspension Bridge, Niagara Falls, Rochester, Syracuse, Rome, and Utica with the Rome, Watertown & Ogdensburg Railroad. Parties from the East can make connection by the Ogdensburg & Lake Champlain Railroad, and passengers on the Grand Trunk Railway can make steamboat connection at Kingston for Clayton or at Gananoque for Alexandria Bay. Excursion tickets will be sold after June 1 from all points on the Rome, Watertown & Ogdensburg Railroad to Alexandria Bay and return.

Further particulars may be obtained from the Committee of Arrangements (H. M. Britton, Rome, Watertown & Ogdensburg Railroad, Oswego, N. Y.; R. C. Blackall, Delaware & Hudson Canal Company, Albany, N. Y.; J. Davis Barnett, Grand Trunk Railway, Port Hope, Ont.) or from the Secretary.

OBITUARY.

THE pressure of other matter on our columns has, much to our regret, crowded out a number of obituary notices which should have been found in this column. The obituary list of the month is an unusually long one, including several distinguished names. We have now only space to notice them briefly. The list includes WILLIAM MERRITT, formerly Superintendent of the Boston & Maine Railroad, on April 15; THOMAS SILVERS, inventor of the marine governor and many other devices, on April 12; ALFRED HUNT, President of the Bethlehem Iron Company, March 27; CLIFFORD ROSSELL, head of the Pennsylvania Railroad's coal companies, April 19; HON. JOHN P. KING, ex-United States Senator and for many years President of the Georgia Railroad Company, March 19; SAMUEL SMITH, founder of what are now the Grant Locomotive Works, March 28; J. O. D. LILLY, Master Mechanic of the United States military railroads during the War, March 22; JOHN M. TUFTS, the oldest living graduate of West Point, March 25; ALFRED NOBEL, inventor of nitro-glycerine and dynamite, April 13; THOMAS MCKISSOCK, engineer and railroad manager, March 22; GEORGE F. HARRIS, contractor and inventor of track-laying machinery, March 18; CHARLES E. WRIGHT, State Geologist of Michigan, March 22; PROFESSOR JAMES C. BOOTH, chemist and metallurgist, March 21; ISAAC HINCKLEY, for many years President of the Philadelphia, Wilmington & Baltimore Railroad Company, March 28; THOMAS ELLIOTT HARRISON, an eminent English engineer and pupil of Robert Stephenson, March 20; GEORGE W. CASS, graduate of West Point, engineer, and President of the Pittsburgh, Fort Wayne & Chicago Company, March 21; CHARLES LATIMER, one of the best-known and best-loved of American engineers, March 25; GENERAL QUINCY ADAMS GILLMORE, the eminent artillerist and engineer, most prominent of all our military engineers, April 7; SQUIRE WHIPPLE, the venerable engineer

and father of modern American bridge building, March 15. This list is one including many whose places will not soon be filled.

PERSONALS.

D. McN. STAUFFER, Associate Editor of *Engineering News*, sailed from New York, March 31, on a vacation trip of several months in Europe.

YEIJA NAKAJIMA, C.E., is Superintendent of Construction of the new water-works at Falls City, Neb., for which plans have been prepared.

FRANK T. CAMPBELL, of Newton, Ia., has been appointed a member of the Railroad Commission of Iowa, succeeding Mr. L. S. Coffin, whose term of office recently expired.

WILLIAM R. BILLINGS has resigned his office as Superintendent of the water-works at Taunton, Mass., to accept a position with the Chapman Valve Company at Indian Orchard, Mass.

E. B. TAYLOR, late Division Superintendent, has been appointed General Superintendent of the Pittsburgh, Cincinnati & St. Louis Railway, succeeding W. A. Baldwin, late Manager.

W. M. CLEMENTS has been appointed General Manager of all the lines of the Baltimore & Ohio Company east of the Ohio River. He has been connected with the road for a number of years.

W. W. PEABODY has been appointed General Manager of all the lines of the Baltimore & Ohio Company west of the Ohio River. He was formerly in charge of the Ohio & Mississippi Railroad.

CHARLES KIRCHHOFF, JR., for some time past Associate Editor of the *Iron Age*, has assumed full editorial charge of that journal, a position for which experience and ability very fully qualify him.

J. J. CASEY has been appointed Master Car Builder of the Louisville, New Orleans & Texas Railroad. He has been for some time Superintendent of the Missouri Car & Foundry Company's works in St. Louis.

M. L. LUM has resigned the position of Chief Engineer of the Chesapeake & Ohio Railway, and the office is abolished. Mr. Lum's address is Richmond, Va., for the present.

W. G. COOLIDGE & COMPANY, engineers, contractors and bridge-builders, have removed their offices to Rooms 609, 610 and 611, Phœnix Building, No. 138 Jackson Street, Chicago, Ill., where all correspondence for them should be addressed.

R. W. BAYLEY, recently Mechanical Engineer of the Pittsburgh, Cincinnati & St. Louis Railway, has entered the service of the Westinghouse Brake Company as General Inspector. He took an active part in the Brake Tests last year.

R. H. SOULE has resigned his position as General Manager of the New York, Lake Erie & Western Railroad. Mr. Soule leaves the Erie, where he has done excellent work, for personal reasons entirely, and will take some much-needed rest before returning to work.

CHARLES C. UPHAM has resigned his position as Superintendent of the Illinois lines of the Chicago, Burlington & Quincy Railroad on account of ill-health. Mr. Upham was Chief Engineer in charge of the construction of the Chicago, Burlington & Northern Railroad.

L. S. COFFIN, for three years past a member of the Railroad Commission of Iowa, has retired on account of the expiration of his term. While a railroad commissioner Mr. Coffin took an exceedingly active interest in everything relating to his office, especially in matters concerning the safety and welfare of railroad employés. He was an interested observer of the Burlington Brake Tests throughout, and the annual reports of the Iowa Commission show the result of his labors.

JAMES C. BAYLES, for 20 years past Editor of the *Iron Age*, has retired from that position on account of pressure of other business. Mr. Bayles was appointed President of the Health Department of New York City about a year ago, and in that capacity he has secured a thorough reorganization of the Department. As Editor of the *Iron Age* he has been extremely successful, and has given that journal an established position. Mr. Bayles has also been an active member of the Institute of Mining Engineers.

DR. W. T. BARNARD has resigned his position as Assistant to the President of the Baltimore & Ohio Railroad Company. He entered the service of the Company eight years ago, for the purpose of organizing a hospital department. When the Employés' Relief Organization was organized Dr. Barnard was placed at its head, the hospital being merged in the larger scheme. In that position he did some excellent work, and the success of the Association was largely due to his efforts. In 1884 he was appointed Assistant to the President, and gave up active charge of the Relief Association, although he continued to give the benefit of his advice to the Managers. Dr. Barnard was also connected with the management of the Baltimore & Ohio Telegraph, and assisted in organizing the School of Technology at the Mt. Clare shops in Baltimore. Before accepting his position with the Baltimore & Ohio, he was connected with the War Department in Washington for a number of years.

NOTES AND NEWS.

A New 150-ton Gun.—The Krupp Works are now turning out a 150-ton gun; it is similar to the 120-ton guns, but is longer and will have a much higher range. It is said that the 120-ton Krupp gun built for the Italian Government, but left at Essen when the others were sent to Italy, has been fired more than 200 times and is still in good condition.

Liquid Fuel in Russia.—The Russian Minister of Marine has decided to fit a number of new torpedo boats now under construction for the navy with furnaces for burning liquid fuel. The selection of the type of furnaces to be used will be made after the close of the competition now in progress at the Petroleum Exhibition in St. Petersburg.

At this Exhibition there are a large number of such furnaces shown, but nearly all of them are Russian or German inventions; no American or English furnaces are in the Exposition.

New Packing Ring.—A correspondent of the London *Engineer* describes a new device of this kind which has recently been brought out in Manchester. It is described as Flöring's patent, and is termed the "Metallographite." These rings are composed of very fine steel wires, and are covered with a fireproof composition. They are inserted between the flanges and carefully flattened by the tightening of the bolt screws. They are claimed to be cheaper and more durable than india-rubber rings, and one advantage is that they can be repeatedly used after being inserted.

Priestman's Petroleum Engine.—This new engine is described in the London *Engineer* as follows: "In a tank in the bed of the engine is placed the petroleum, which is forced through a pipe into a compartment where the oil is converted into a fine spray by means of a blast of air. The spray passes into a chamber, is rendered explosive, and, coming in contact with an electric spark—obtained from a small battery in the rear—motive power is at once supplied. In construction it is comparatively simple; it works with admirable regularity, and the piston requires no oiling, the petroleum vapor supplying the necessary lubrication."

New Transatlantic Steamers.—The new twin-screw passenger steamer, *City of New York*, was launched from the ship building yard of James & George Thomson, on the Clyde, March 15. This vessel is one of the two now under construction for the Inman line, which will be the largest vessels in the world, with the exception of the *Great Eastern*, their gross tonnage being 10,500 tons. A description of these vessels was published in the JOURNAL for March; they will be 525 ft. long on the water line, 560 ft. over all, 63½ ft. beam, and 42 ft. moulded depth. The chief peculiarities of these vessels are the system of bulkheads with which they are provided, and the use of twin screws driven by separate engines.

The Longridge Wire-Wound Gun.—The first wire gun constructed entirely on Mr. Longridge's principle by Admiral Kolokoltzoff, at the Abouchoff Steel Works, has just been successfully tested. The gun is 35 calibers long, with a powder chamber 6.84 in. diameter, and weighs 5.6 tons. The inner tube is of steel, with 85 in. of its breech-end strengthened with steel wire encased in a cast iron jacket on which the trunnions are formed, and which carries a breech mechanism of the De Bange type. The wire, weighing 1,656 lbs., is 0.252 in. wide by 0.059

in. thick, was wound on in an ordinary lathe by means of an automatic apparatus constructed by Messrs. Easton & Anderson, and attached to the saddle of the ordinary slide rest. Up to the present time 163 rounds have been fired ; 500 in all will be required to complete the test. The success of the gun so far is perfect, and completely justifies Mr. Longridge's contention that trustworthy ordnance can be constructed cheaply, and, above all, very quickly, on his system.—*London Engineer.*

The Aral-Caspian Canal.—The Russian Government has recently revised the project, first originated by Peter the Great, of diverting a part of the flow of the River Oxus, or Amu-Daria, to the Caspian Sea, and a considerable force of engineers is now employed in making surveys to test the practicability of the project. The river now flows into the Aral Sea, which has, as is well known, no outlet. The diversion of part of its flow into the Caspian Sea would have the effect probably of reducing the area of the Aral Sea and the great marshes which surround it considerably, but it is not considered that such a result would be undesirable. The intention of Peter the Great was to make a navigable canal by which vessels on the Caspian could penetrate into Central Asia. The building of the Russian Military Railroad has done away with the necessity for this, and the present object of the Government is not so much to make a navigable canal, as to secure a supply of water which can be used to irrigate the great plain between the Caspian and Aral. Recent examination has lead the Russian engineers to believe that a very large part of this district can be cultivated, provided a supply of water can be secured.

Draining the Zuyder Zee.—The preliminary work for the drainage of the Zuyder Zee in Holland is progressing well and excites much interest in that country. If the enterprise is successful it will remove altogether this troublesome and turbulent inlet from the North Sea, and will add a new province to the country.

For the purpose of pushing the project energetically a company was last year formed, which is known as the Zuyder Zee Union. A distinguished Dutch engineer has made a careful study of the proposed work and has submitted his plans. According to these the province of North Holland will be connected with Friesland and Groningen by two great dykes. As soon as these are completed the work of draining the land will be begun. The entire area of the Zuyder Zee will be drained, except a small portion, which will be left as a permanent lake ; a large canal will run from this lake to Amsterdam. This lake will receive the waters of the River Yssel on the one side, and on the other it will have a connection with the North Sea through several locks. The Union has recently taken a subscription of 90,000 gulden to continue the preparatory works.

Boiler Explosions in France.—The Ministry of Public Works reports that there were in France last year 30 boiler explosions, by which 33 persons were killed and 24 injured. The classes of boilers which exploded were :

Boilers without interior fire-box :

Horizontal, not tubular	10
Horizontal, tubular	1
Vertical	2

Boilers with interior fire-box :

Horizontal, tubular	8
Vertical	1
Receivers and other steam apparatus	8
Total	30

The causes assigned were : Defective construction or material, 9 ; fatigue of metal or grooving of plates, 9 ; repairs neglected or badly made, 3 ; low water, 6 ; excessive pressure, 3 ; other cases of neglect, 3 ; unknown, 3.

It will be observed that the number of causes given is greater than that of explosions ; this arises from the fact that in several cases more than one cause is assigned for an explosion.

Traffic of the Suez Canal.—The number of ships which passed through the Suez Canal last year was 3,137, their gross tonnage being 8,430,043 tons. The largest movement of shipping through the canal in any one month occurred in May, when 303 ships of an aggregate burden of 797,547 tons paid transit dues. Of the 3,137 ships which went through the canal last year 2,330 were English, leaving a balance of only 807 carrying the flags of other nations. In this total of 807 ships, France figured for 183 ; Germany for 159 ; Italy for 138 ; Holland for 123 ; Austria (and Hungary) for 82 ; Norway for 28 ; Spain for 26 ; and Russia for 22. Only three American vessels used the canal in 1887. The number of persons passing through the canal as passengers last year was 173,786, of whom 91,996 were soldiers, 53,415 civil passengers, and 19,610 Mohammedan pilgrims. The total of 3,137 ships passing through the canal last year compared with a passage of 3,100 in 1886 ; 3,624 in 1885 ; 3,284 in 1884 ; and 3,307 in 1883. The average time occupied by each ship in the canal last year was 34 hours, as compared with 36 hours in 1886 ; 43 hours in 1885 ; 42 hours in 1884 ; and 48¼ hours in 1883. The considerable reduction observable in the average in 1887 and 1886 is due to sundry extensions and improvements carried out since 1885, which have considerably facilitated the passage of shipping.

The Mekarski Air Engine.—After various delays several tram-cars driven by compressed air on the Mékarski system have recently been placed on a tramway line in the north of London, where they are regularly taking their turn in working the traffic with the ordinary horse-drawn cars. The Mékarski system consists of a station where the air is compressed and stored for delivery into reservoirs placed under the cars. The air in its passage from the reservoirs to the driving engines, which are also under the cars, passes through hot water and steam, which are charged into a receiver on the car at the compressing station. The heat further expands the air, and also prevents the formation of snow in the cylinders due to the expansion of the compressed air. The tramway upon which the cars are running is that section of the London Street Tramways Company's lines between Holloway Road and the King's Cross Station of the Metropolitan Railway. It is about two miles in length, and has several heavy gradients and sharp curves. The Mékarski cars, which resemble the ordinary horse-drawn cars, take their turn regularly with the other cars on the line, keeping time and observing all the other conditions of traffic. The introduction of the air-driven cars by the Tramways Company on its line has been decided on in consequence of the economy of the system over horse traction, and this notwithstanding that both horses and forage are at comparatively low prices.

A Cable Railroad in Venezuela.—The Government of Venezuela has recently granted a concession giving the La Guayra & Caracas Cable Company, represented by T. W. Tyrer, the exclusive right to build and operate a cable railroad between the port of La Guayra and the city of Caracas. The Company is to begin the work of construction within nine months from December 1, 1887, and to complete the road in three years. It is to have an exclusive right for 99 years, the Government agreeing that no company or person shall be allowed to operate a parallel or competing line. The Company is also to have the right to build stations, warehouses, and wharves at La Guayra and to build necessary stations and warehouses at Caracas. It is to have free right of way and a grant of land for terminal buildings at both ends of the line. The maximum fares and rates of freight to be charged are prescribed, and the Company is required to carry Government freight, soldiers, and other passengers on public service at one half the maximum rate.

The construction will involve some difficult engineering. The city of Caracas, which is the capital of Venezuela, is only a few miles distant from La Guayra in a direct line, but is several thousand feet above it, and the journey between the two places involves the crossing of the lofty mountain range. The cable road was considered the only practicable method of overcoming the extremely heavy grades which would be necessary in any line between the two places which did not make a very wide circuit. The building of the line will also involve the construction of several tunnels of considerable length.

Naval Notes.—The Secretary of the Navy has approved the modified plans for the machinery of the *San Francisco* to be constructed by the Union Iron Works. The plans call for triple-expansion twin-screw engines of 36 in. stroke ; diameter of cylinders, 42, 60 and 94 in., respectively ; horse power, 11,000. All engine frames and pillow-blocks of forged steel ; all crank shaft pillow-blocks, links, and valve gear interchangeable ; the crank-shafts made in sections all alike and interchangeable so that there is no chance of a complete break down ; valves of the piston type for the high pressure and intermediate cylinders ; air pump double, and worked independently of the main engines ; condensers cylindrical and built of brass and composition with a total cooling surface of 14,500 square feet ; four double-ended cylindrical boilers with a total heating surface of 19,500 square feet ; also an auxiliary boiler. The draught to be forced by eight blowers blowing into closed ash-pans.

The Richmond Locomotive Works (formerly the Tanner & Delaney Engine Company) will, it is said, receive the contract to build the engines for the *Texas*, the battleship which is to be built at the Norfolk Navy Yard.

The contract for the building of the new torpedo boat by the Herreshoff Company has been concluded. The construction of this boat will be under the supervision of the Bureau of

Ordnance. The force of draftsmen in the Bureau of Steam Engineering is busily engaged on the plans for the machinery of the *Monadnock*, the unfinished monitor at the Mare Island Navy Yard, California.

The Standard Steel Company at Chester, Pa., has cast a 6-in. steel gun, weighing 12½ tons. It is of Siemens-Martin steel, and the casting was, apparently, a success. It will be bored and turned up, and then subjected to the same tests as the Pittsburgh cast-steel gun.

Photographing the Pacific Coast.—Professor Davidson, of the Coast Survey, has long since planned a scheme for photographing the whole line of the Pacific seaboard from selected stations, say at distances of 10 and 20 miles broad off the shore. The farther ones would give the landfall or crest line of the coast mountains as it would appear to the navigator approaching the coast directly from seaward. The stations along the seaboard would be not over 10 miles apart and probably less. The inner line of stations would give the details to the steamships and sailing vessels coasting northward and southward. In addition to these two series there would be a set of three views of every headland as seen when approaching it from the southward, when abreast of it, and when approaching it from the northward. The islands would be sketched or photographed from four or more directions according to circumstances.

Views for channel ranges are very important in approaching and entering bays and ports, and are particularly useful for approaching dangerous anchorages, such as the many landings, chutes, and harbors visited by our smaller lumber vessels and produce schooners.

There is evidently an immense amount of this kind of work to do, and Superintendent Thorn has just transmitted to Professor Davidson a copy of the authority given by the Secretary of the Treasury to Captain Shepard, commanding the revenue cutter *Rush*, to receive him on board his vessel, in order that he may take views along that part of the coast where the vessel will be cruising.—*San Francisco Call.*

Blast Furnaces of the United States.—The *American Manufacturer*, in its usual monthly tables, gives the condition of the blast furnaces of the United States on April 1.

"The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	60	12,393	114	12,996
Anthracite	95	27,971	105	27,373
Bituminous	130	75,983	84	44,928
Total	285	116,347	303	85,297

"The appended table shows the number of furnaces in blast on April 1, 1888, and on April 1, 1887, with their weekly capacity:

	April 1, 1887.		April 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	59	11,337	60	12,393
Anthracite	143	39,477	95	27,971
Bituminous	151	86,709	130	75,983
Total	353	137,523	285	116,347

"This table shows the following changes during the year: Charcoal—increase in number of furnaces blowing, 1; increase in weekly capacity, 1,056 tons; anthracite—decrease in number of furnaces blowing, 48; decrease in weekly capacity, 11,506 tons; bituminous—decrease in number of furnaces blowing, 21; decrease in weekly capacity, 10,726 tons. Total decrease of number in blast, 68; total decrease in weekly capacity, 21,176 tons."

Origin of Artesian Wells.—The sedimentary rocks, in their great thickness, inclose a succession of water-sheets or water-levels occupying distinct stages, and extending, with uniform characters, under whole countries, like the strata to which they are subordinated. It is proper to remark here that by the term water-sheet is not meant a real bed of water, lodged in a cavity, between solid masses that serve as walls to it, but water filling the minute interstices or the cracks of a rock. Continuous and regular in sand, these sheets are usually discontinuous and irregular in limestones and sandstones, in which the water only occupies more or less spacious fissures. When natural issues are wanting, human industry is able, by boring, to make openings down to the subterranean waters, which it causes to jet up to the surface, and sometimes to a considerable height above. The thought of undertaking such works is a very ancient one. The Egyptians had recourse to them 40 centuries ago; and they were executed in France, in 1126, at Artois, whence the name of artesian wells has been given to them.

The water-levels of the cretaceous strata, from which the French artesian waters issue, are not always of advantage; but in the north of France and in Belgium they constitute the most formidable obstacle which miners have to encounter in reaching the coal-beds.

A striking confirmation of the theory of the source of supply of the artesian waters has been observed at Tours, where the water, spouting with great velocity from a well 110 meters in depth, brings up, together with fine sand, fresh-water shells and seeds, in such a state of preservation as to show that they could not have been more than three or four months on their voyage. Some of the wells of the Wady Rir have also ejected fresh-water mollusks, fish, and crabs, still living, which must, therefore, have made a still more rapid transit.—*Professor G. A. Daubree, in Popular Science Monthly.*

The German Universal Exposition for Prevention of Accidents.—Minister Pendleton, at Berlin, transmits to the State Department a letter from the President of this Exposition for the purpose of making known in the United States the objects to be attained. The Exposition is to be held in Berlin from April to July, 1889, and is to contain apparatus and appliances meant to protect workmen against the dangers which threaten them in industrial occupations, from the knowledge and introduction of which a reduction in the number of industrial accidents may be expected.

The humanitarian views which prompt this Exposition have won the full sympathy and support, not only of the principal representatives of industry and agriculture in Germany, but also of the German Imperial and Prussian state officials.

As may be seen from the full programme, the Exposition aims not only to promote a knowledge of the apparatus and appliances calculated to prevent accidents, but also to stimulate an interest in their further development, and to furnish the inventors of similar protective contrivances an opportunity to demonstrate their practical utility. The Exposition will, therefore, have much of the character of an industrial exposition, differing only from the purely industrial expositions in that such articles only will be admitted whose aim or make has a demonstrable relation to the prevention of accidents. Such articles and appliances may also be admitted which tend to the workmen's protection and general welfare, and are therefore to lead directly or indirectly to a diminution of industrial accidents.

As the workmen and handicraftsmen of all lands have an equal concern in the decrease of accidents in industrial occupations, there can be no doubt that this Exposition will also be of interest for other countries, especially as, according to the "Conditions for Exhibitors" found in the programme, foreigners are allowed to enter their exhibits.

Internal Stresses in Guns.—From the failures which frequently occur with guns of large caliber, it would appear that the initial stresses in the interior of the metal of the various rings, which have hitherto been treated in practice as negligible quantities, have an importance as yet not properly allowed for by their designers. The reason of such neglect is by no means obvious, as in the case of ordinary cast-iron guns, their importance has long been known, and acted on in a practical way by Rodman and others, but in modern steel guns, where both theory and experiment concur in the conclusion that their effects are intensified, they have, until lately, been treated as non-existent. This increase, in the case of steel, is due to the higher elastic limit of this metal as compared with cast iron, for the internal stresses cannot exceed that corresponding to the elastic limit, or the metal will take a permanent set and relieve itself of the excess, and consequently the value of the stresses in question can attain a much higher value with the more modern material. The only person who seems to have fully understood the great importance of these internal stresses is General N. V. Kalakouski, of the Russian Artillery, who has carried out a most painstaking and laborious series of experiments with a view to determining the actual values attained by these stresses in different cases, and of these experiments a fairly complete account is given in a recent issue of the *Revue d'Artillerie*. The plan adopted was to cut disks of metal from steel cylinders, and to engrave on the face of each a series of concentric circles, dividing the disk up into a series of annular rings, the diameters of which were then carefully measured. The rings were then turned off successively in a lathe, fresh measurements of the diameters being made between each operation. It was then found that the values of the diameters had in general changed, thus proving the existence of internal stresses, the numerical values of which could be computed from the diametrical alterations, and frequently amounted to many tons per square inch.